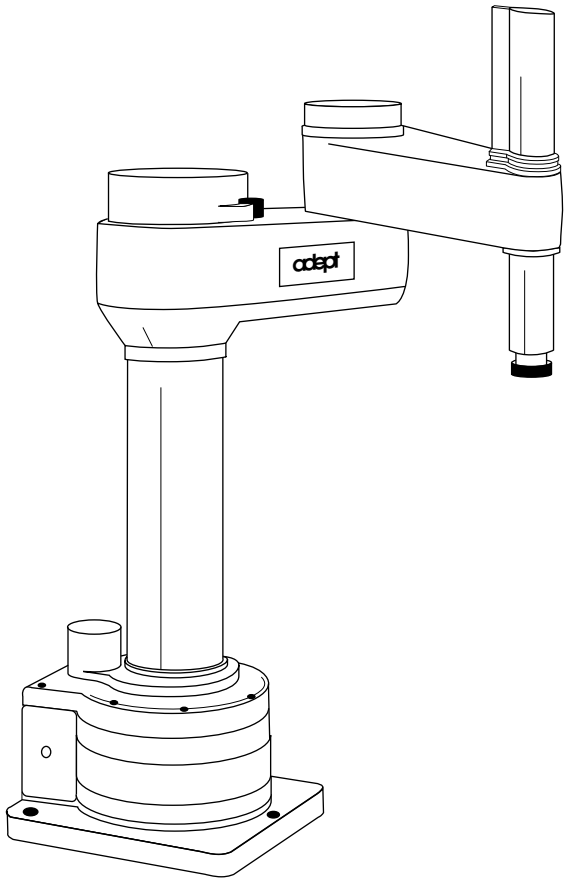
# Instruction Handbook

# AdeptOne-MV/ AdeptThree-MV Robot

## Including Manual Mode Safety Package




adept

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# AdeptOne-MV/ AdeptThree-MV Robot

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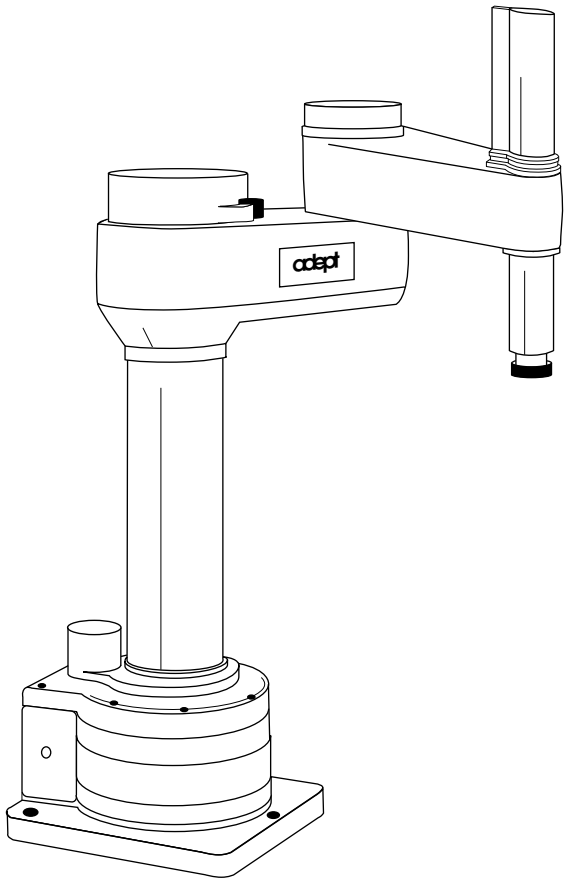


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## MANUFACTURER'S DECLARATION

We, **Adept Technology**, with Corporate Headquarters at 150 Rose Orchard Way, San Jose, CA., USA, and European Technical Center at Otto-Hahn-Str. 23, 44227 Dortmund, Germany, herewith declare that the Robot comprised of:

1. **Controller: MV-8 (P/N 30330-15000), MV-19 (P/N 30330-25000)**
   **MV-5 (P/N 30340-10000), or MV 10 (P/N 30340-20000)**
2. **PA-4 Power Chassis (P/N 30336-31000)**
3. **A Power Amplifiers (P/N 10337-15200)**
4. **B+ Power Amplifiers with voltage restrict (P/N 90338-51010)**
5. **Manual Control Pendant (MCP III) (P/N 90332-48050)**
6. **VME Front Panel Category 3 (P/N 90335-00380)**
7. **Category 3 Security Panel (P/N 30335-00000)**
8. **Accelerometer (P/N 30335-10000)**
9. **Robot from the AdeptOne-MV Family**
   **AdeptOne-MV (Model Number 843)**
   **AdeptOne-MV Cleanroom(Model Number 843 modified with Class 10 Cleanroom Kit (P/N 90842-00000))**
   **PackOne-MV (Model Number 848)**
   **AdeptThree-MV (Model Number 643)**

in the form delivered by us to which this Declaration relates, complies with the relevant and fundamental safety and health requirements defined in the EC Directive 89/336/EEC, Appendix 1, and the following standards:

**EN 55011:1991, Class A**
**EN 50082-2: 1992**
**EN 292: 1992**
**EN 60204-1: 1992, IP20**
**EN 954, Category 3**
**EN 775; 1992**

following the provision of Directives:

**89/336/EEC**
**89/392/EEC**
**73/23/EEC**

under the following usage and environmental conditions:

**1. The system must not be put into operation until all of the machinery into which it is incorporated has been declared in compliance with the provisions of the effective versions of the Directives. This includes all supplementary equipment and protective devices.**

**2. The system must be used in accordance with the Instruction Handbook for the AdeptOne-MV Robot with Manual Mode Safety Package.**

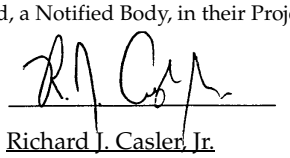
**3. The system must incorporate only those MV Plug-in Modules listed in Table 1 or Table 2. If Plug-in Modules listed in Table 2 are installed, the user must verify conformance to the EMC Directive after installation.**

**4. PackOne mechanism is IP55.**

This Declaration is based upon extensive tests and evaluation by TÜV Rheinland, a Notified Body, in their Project Number E9572254. The complete File is available at the California address.

Place: San Jose, California, USA

Date: 1 February 1996

Signed: 

Full Name: Richard J. Casler, Jr.

Position: Vice President, Engineering

## English

Manufacturer's Declaration
as defined in Machinery Directive 89/392/EEC, Appendix IIB

We herewith declare that the machine as delivered by us complies with the relevant and fundamental safety and health requirements defined in the EC Directive, Appendix 1.
The machine must not be put into operation until all of the machinery into which it is incorporated has been declared in compliance with the provisions of the effective versions of the directives. This includes all supplementary equipment and protective devices.

## Deutsch

Herstellererklärung
im Sinne der EG-Maschinenrichtlinie 89/392/EWG, Anhang II B

Hiermit erklären wir, daß die nachstehende Maschine in der von uns gelieferten Ausführung, den einschlägigen, grundlegenden Sicherheits- und Gesundheitsanforderungen der EG-Richlinie Anhang I, entspricht.
Wir weisen daraufhin, daß die Inbetriebnahme der Maschine solange untersagt ist, bis festgestellt ist, daß die Maschine, in die diese Maschine eingebaut werden soll, den Bestimmungen der Richtlinie in der jeweils gueltigen Fassung entspricht. Dies schließt die anwenderseitig in die Maschine zu installierenden Ergänzungen und Schutzeinrichtungen ein.

## Française

Déclaration du Constructeur
selon la Directive Communautaire relative aux machines
89/392/CEE, Annexe II B.

Par la présente, nous déclarons que la machine décrite ci-dessous, livrée en l'état, est conforme à la directive communautaire, Annexe I, sur les impératifs fondamentaux en matière de santé et de sécurité.
La machine ne pourra être mise en service avant que la machine dans laquelle elle sera incorporée ne soit déclarée complètement conforme aux dispositions des directives en cours de validité. Ceci comprend tout équipement complémentaire et dispositif de protection.

## Italiano

Dichiarazione del Costruttore
ai sensi della direttiva CE 89/392/EEC relativa a macchinari Appendice IIB

Si dichiara che la macchina , come da noi fornita, soddisfa i requisiti fondamentali definiti nella direttiva CE, Appendice I,in fatto di sicurezza e sanità.
La messa in funzione della macchina resta vietata fintanto che l'intero sistema nel quale questa è incorporata sia stato dichiarato conforme alla versione vigente della suddetta normativa. Il sistemasi intende comprensivo di tutte le parti accessorie e dispositivi di sicurezza.

**Table 1**

**VME Plug-in Modules that meet all applicable Directives and that may be installed, without additional EMC conformance testing, in MV-8 and MV-19 Controllers**

| Part Number | Minimum Acceptable Revision | Description |
|---|---|---|
| 10332-11150 | P6 | PCA, VME 030 Processor |
| 10332-00710 | P1 | PCA, VME 040 Processor |
| 30332-12350 | P2 | SYSIO 2 Module Assy FD/HD (SIO2) |
| 30332-12351 | P2 | SYSIO 2 Module Assy FD |
| 10332-00800 | P2 | PCA, VME Digital I/O (DIO) |
| 10332-10250 | P3 | PCA, VME Graphics Board (VGBIII) |
| 10332-00600 | P2 | PCA VME Frame Grabber (VIS) |
| 10332-11400 | P4 | PCA, VME Motion Interface, MI-3 |
| 10332-12400 | P2 | PCA, VME Motion Interface, MI-6 |
| 10332-00500 | P2 | PCA, VME Joint Interface (VJI III) |

**Table 2**

**Plug-in Modules and Accessories that may be installed in MV-8 and MV-19 Controllers but must first be tested in the final system configuration to assume full compliance.**

| Part Number | Minimum Acceptable Revision | Description |
|---|---|---|
| 90332-02020 | P1 | AdeptNet 10BaseT Kit |
| 10330-00970 | B | PCA, VME Analog I/O (AIO) |
| 90211-00000 | B | Adept Force Kit |

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# 1 Safety


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## 1.1 Introduction

The AdeptOne-MV, AdeptThree-MV and Adept PackOne-MV robots are four-axis SCARA robots (see Figure 1-1). Joints 1, 2, and 4 are rotational and Joint 3 is translational. See Figure 1-3 for a description of the robot joint locations.

The AdeptOne-MV, AdeptThree-MV and Adept PackOne-MV, robots are designed to interface with the Adept MV controller and PA-4 power chassis (see Figure 1-2). The control and operation of the robot is programmed and performed through the controller. Additional safety features are controlled by the Security Panel.

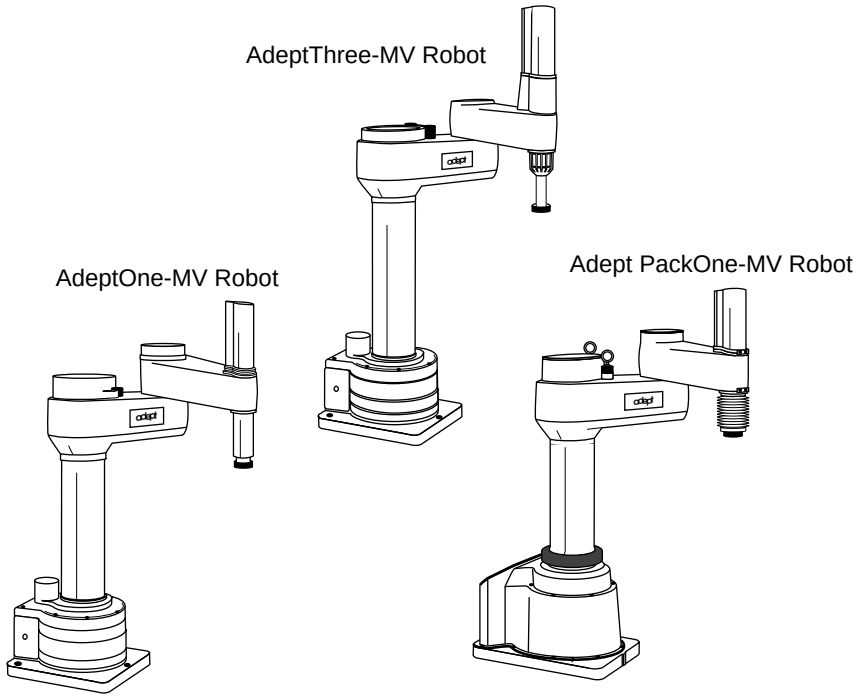


**Figure 1-1. Adept Robots**

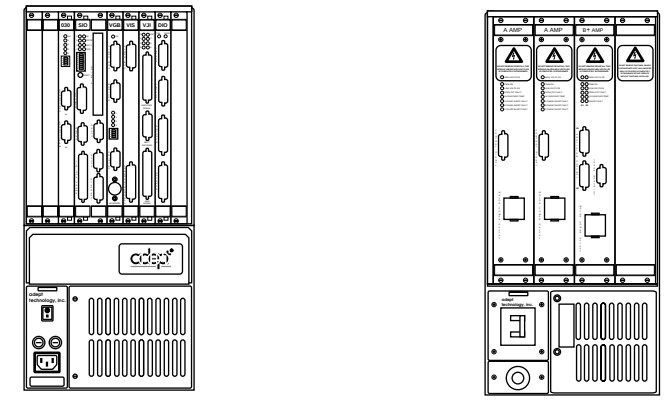


**Figure 1-2. Adept MV-8 Controller and PA-4 Power Chassis**

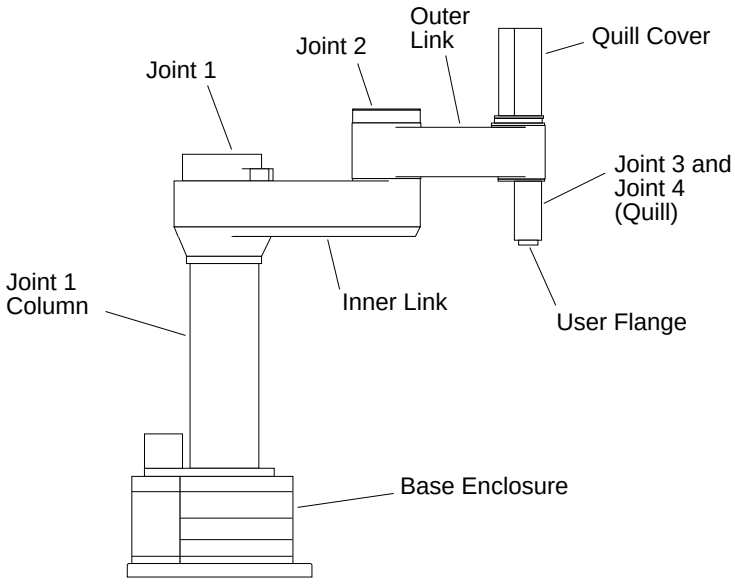


**Figure 1-3. Adept Robot Joint Locations**

## Adept Equipment Compatibility

This handbook describes the AdeptOne-MV, AdeptThree-MV, and PackOne-MV robots with the Manual Mode Safety Package. The Manual Mode Safety Package provides a Category 3 level of safety, as specified in EN 954, section 1.3.

The Adept Category 3 robot system as described in this handbook must consist of the hardware and software listed in the following table. All new systems shipped from the factory will include the correct equipment as shown. If you have existing Adept equipment, this table can help distinguish new equipment from older equipment, especially since some of it is visibly similar. See the product data label for the robot, controller, and power chassis for model number or part number information.

For information on the V$^+$ 11.3 Operating System, refer to the *V$^+$ 11.3 Release Notes* that is shipped with each system.

**Table 1-1. Adept Hardware and Software Compatibility for Category 3 Systems**

| Product | Required Model, Part, or Version Number |
|---|---|
| Standard AdeptOne robot | Model Number 843 |
| CleanRoom AdeptOne robot | Model Number 843 with Class 10 CR Kit |
| PackOne robot | Model Number 848 |
| AdeptThree robot | Model Number 643 |
| Adept MV-8 controller[a] | part number 30330-15000 |
| Adept MV-19 controller[a] | part number 30330-25000 |
| Adept PA-4 power chassis | part number 30336-31000 |
| A Power Amplifier | part number 10337-15200 |
| Manual Mode Safety Package consisting of:<br>Category 3 Security Panel<br>B+ Power Amplifier with voltage restrict<br>External VME Front Panel (VFP) | <br>part number 30335-00000<br>part number 90338-51010<br>Category 3, part number 90335-00380[b] |
| Manual Control Pendant | MCP III, part number 90332-48050[c] |
| $V^+$ Operating System software | Version 11.3 or later<br>Note: Category 3 hardware cannot be used with earlier versions of $V^+$ |

[a] See Tables 1 and 2 in the Manufacturer's Declaration at the front of this handbook for information on approved plug-in modules for Adept MV controllers.
[b] The new Category 3 VFP has two keyswitches, older versions have only one.
[c] The label on the back of the new MCP III is "Manual Control III Operator." Also on the new MCP, the button in the lower right corner (below T1) is labeled STEP.

### Definition of a Manipulating Industrial Robot

An automatically controlled, reprogrammable, multi-purpose, manipulative machine with several degrees of freedom, which may be either fixed in a place or mobile for use in industrial automation applications is called a manipulating robot. (ISO 10218:1992(E))

## 1.2 Notes, Cautions, and Warnings

There are four levels of special notation used in this instruction handbook. In descending order of importance, they are:

**WARNING:** If the actions indicated in a "WARNING" are not complied with, injury or major equipment damage could result. A Warning statement will typically describe the potential hazard, its possible effect, and the measures that must be taken to reduce the hazard.

**WARNING:** If in a "WARNING" the actions are indicated with an lightning bolt instead of an exclamation mark, an electrical danger or shock is possible for personnel working with the system.

**CAUTION:** If the action specified in the "CAUTION" is not complied with, damage to your equipment could result.

**NOTE:** A "NOTE" provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

## 1.3 Risk Assessment – Category 3 System

Without special safeguards in its control system, the AdeptOne robot could inflict serious injury upon an Operator working within its work envelope. As a consequence of:

1) the potential for fatal injury,
2) the likelihood that the Operator would need to be within the work envelope for significant periods of time during the commissioning or reteaching of the robot program, and
3) the high probability that an Operator could not avoid being hit by the robot in a high-acceleration, runaway, failure condition,

EN 1050 specifies use of a Category 3 Control System per EN 954.

EN 954 defines a Category 3 Control System as one in which

1) no single failure can cause a loss of the safety function, and
2) any failure that does occur can be "checked" prior to enabling power.

The AdeptOne-MV Control System (Control System) described in this Handbook employs a fully-redundant Emergency Stop that incorporates proprietary "Teach Restrict" sensors and self-checking hardware. Through use of a thorough Failure Mode and Effect Analysis, it has been determined that the AdeptOne-MV Control System, with the Manual Mode Safety Package as described in this Handbook, meets the stringent requirements of the Category 3 level of safety specified in EN 954. The Control System also has been designed to meet relevant standards referenced in EN 954, including EN 775/ISO 10218 – Manipulating robots safely. See also the Manufacturer's Declaration at the front of this Handbook.

## 1.4 Precautions and Required Safeguards

This manual must be read by all personnel who install, operate, or maintain Adept systems, or who work within or near the workcell.

**WARNING:** Adept Technology strictly prohibits installation, commissioning, or operation of an installation with an Adept robot without the adequate safeguards according to the standards EN 775/ISO 10218, sections 5,6; EN 292-1, and EN 60204, section 13.

### Robot Static Forces

Adept robot systems include computer-controlled mechanisms that are capable of exerting considerable force. Like all robot and motion systems, and most industrial equipment, they must be treated with respect by the user and the operator.

The following table shows the forces that can be generated by an AdeptOne-MV robot.

**Table 1-2. Robot Torques and Forces**

| | |
|---|---|
| Joint 1 maximum static torque | 400 Nm (295 ft-lb) |
| Joint 2 maximum static torque | 280 Nm (207 ft-lb) |
| Maximum static force applied by the robot in XY plane, measured at user flange | 1250 N (280 lb) |

### Safety Barriers

Safety barriers must be an integral part of robot workcell design, installation, Operator training, and operating procedures. Adept systems are computer-controlled, and may activate remote devices under program control at times or along paths not anticipated by personnel. It is critical that safeguards be in place to prevent personnel from entering the workcell whenever equipment power is present.

The AdeptOne-MV, AdeptThree-MV and PackOne-MV robots are not safe on their own. The Robot System Integrator (or end-user) must ensure that adequate safeguards, safety barriers, light curtains, safety gates, safety floor mats, etc. will be installed. The robot workcell must be designed according to EN 775/ISO 10218, sections 5,6; EN 292-1, 3.71, and EN 60204, section 13.

The safety distance to the robot depends, relating to the standard EN 294, on the height of the safety fence. The height and the distance of the safety fence must ensure that nobody can reach the danger zone of the robot, see EN 294.

Adept controller systems for AdeptOne-MV, AdeptThree-MV, and Adept PackOne robots have various control features which can aid the integrator or user in constructing system safeguards, including Customer Emergency stop circuitry and digital input and output lines. The emergency power-off circuitry is capable of switching external power systems, and can be interfaced to user-supplied Category 3-compliant safeguards. See Chapter 3 for information on safe and effective use of the robot.

### Impact and Trapping Points

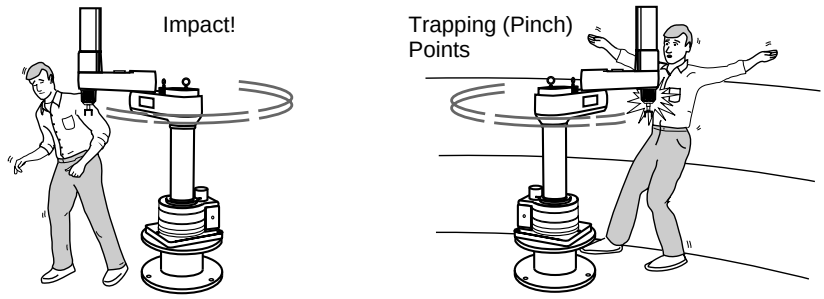


**Figure 1-4. Robot Impact and Trapping Point Hazards**

Adept robots are capable of moving at high speeds. If a person is struck by a robot (impacted) or trapped (pinched), serious injury or death could occur. Robot configuration, joint speed, joint orientation, and attached payload all contribute to the total amount of energy available to cause injury.

### Hazards from Expelling a Part or Attached Tooling

The maximum joint and user flange tip speeds that can be achieved by the AdeptOne-MV, AdeptThree-MV, and PackOne-MV robots in a *runaway* situation are listed in Table 1-3. Any tooling, fixtures, end-effectors, etc., mounted to the user flange, outer link, or inner link of the robot must be attached by sufficient means to resist being expelled from the robot. Additionally, any payload must be attached to the end-effector in a manner that prevents the payload from being expelled accidentally.

**Table 1-3. Maximum Robot Joint Velocities in Runaway Situations[a]**

| | |
|---|---|
| Joint 1 maximum angular velocity | 920 degrees/second |
| Joint 1 maximum linear velocity | 10.7 meters/second |
| Joint 2 maximum angular velocity | 1670 degrees/second |
| Joint 2 maximum linear velocity | 20.8 meters/second |

[a] These velocities can only occur in a runaway or mechanical failure situation. These are *not* performance specifications; see Chapter 6 for robot performance specifications.

The safety fence or barrier constructed around the robot must be designed to withstand the impact of any item expelled accidentally from the robot. Projectile energy can be calculated using the formula $E = 1/2mv^2$. Here are two examples.

**Example 1**: 4 kg payload mounted to end-effector.

maximum possible projectile energy = $1/2\ (4kg)\ (20.8m/s)^2 = 865$ J (638 ft-lb)

**Example 2**: 6 kg payload mounted to elbow (Joint 2).

maximum possible projectile energy = $1/2\ (6kg)\ (10.7m/s)^2 = 343$ J (253 ft-lb)

### Robot Kinetic (Stored) Energy

The AdeptOne-MV and PackOne-MV have a fail-safe mechanical brake on Joints 1, 2, and 3 only. Joint 4 does not have a mechanical brake; it is decelerated by friction and the regenerative capability of the amplifiers. In the event of an emergency stop, Joint 4 may continue to move due to its own stored kinetic energy (inertia) and that of the payload. The mass of the Joint 4 (flange and quill) is approximately 3.5 kg (7.7 lb).

The AdeptThree-MV has a fail-safe mechanical brake on axes 1, 2, 3, and 4.

## Additional Safety Information

The standards and regulations listed in this handbook contain additional guidelines for robot system installation, safeguarding, maintenance, testing, start-up, and operator training. The table below lists sources for the various standards.

**Table 1-4. Sources for International Standards and Directives**

| |
|---|
| BSI, British Standards Institute<br>Sales Department<br>Linford Wood<br>Milton Keynes<br>MK14 6LE United Kingdom<br>Phone 0181 996 7000<br>Fax 0181 996 7001 |
| Beuth Verlag GmbH<br>10722 Berlin<br>Germany<br>Phone 030 26 01 - 22 60<br>Fax 030 26 01 - 12 60 |
| IEC, International Electrotechnical Commission<br>Rue de Varembe 3<br>PO Box 131<br>CH-1211 Geneva 20, Switzerland<br>Phone 41 22 919-0211<br>Fax 41 22 919-0300 |
| American Electronics Association Europe<br>40 Rue des Drapiers<br>1050 Brussels, Belgium<br>Phone +322/502 7015<br>Fax +322/502 6734 |
| American National Standards Institute<br>11 West 42nd Street, 13th Floor<br>New York, NY 10036<br>Phone 212-642-4900<br>Fax 212-398-0023 |
| Document Center, Inc.<br>1504 Industrial Way, Unit 9<br>Belmont, CA 94002<br>Phone 415-591-7600 |

## 1.5 Intended Use of the Robots

The installation and usage of Adept products must comply with all safety instructions and warnings in this manual. Installation and usage must also comply with all applicable European, international or local requirements and safety standards.

The AdeptOne-MV robot is intended for use in small parts assembly and material handling for payloads typically less than 8kg (17.6 lb).

The AdeptThree-MV robot is intended for use in parts assembly and material handling for payloads typically less than 25kg (55 lb) and for those applications that require a longer reach than the AdeptOne-MV or the Adept PackOne-MV Robot.

The Adept PackOne-MV robot is intended for use in applications that require washdown environments, with payloads typically less than 7.7 kg (17 lb).

A HyperDrive Option is available for these robots that delivers higher power to the Joint 1 and 2 motors. This option is used for applications that require faster throughput.

**WARNING:** For safety reasons it is prohibited to make certain modifications to Adept robots, see section 1.6.

The Adept MV controller and the Adept PA-4 power chassis are intended for use as component sub-assemblies of a complete industrial automation system. The controller and power chassis sub-assemblies must be installed inside a suitable enclosure. The controller and power chassis sub-assemblies must not come into contact with liquids. Additionally, the AdeptOne-MV and the AdeptThree-MV robots must not come into contact with liquids.

The Adept equipment is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres
- In mobile, portable, marine, or aircraft systems
- In life-support systems
- In residential installations
- In situations where the Adept equipment will be subject to extremes of heat or humidity. See specifications for allowable temperature and humidity ranges.

**WARNING:**
The given instructions about operation, installation, and maintenance in this Instruction Handbook must be strictly observed.

Non-intended use of an AdeptOne-MV, an AdeptThree-MV, or a PackOne-MV Robot can:

- cause injury to the personnel.
- damage the robot or other equipment.
- reduce the system reliability and the performance of the system.

All persons that install, commission, operate, or maintain the robot must:

- have the necessary qualifications
- read and follow exactly the instructions in this Instruction Handbook.

If there is any doubt concerning the application, ask Adept to determine if it is an intended use or not.

## 1.6 Robot Modifications

It is sometimes necessary to modify the robot in order to successfully integrate it into a workcell. Unfortunately, many seemingly simple modifications can either cause a robot failure, or reduce the robot's performance, reliability, or lifetime. The following information is provided as a guideline to modifications.

### Acceptable Modifications

In general, the following robot modifications will not cause problems, but may affect robot performance:

- Attaching tooling, utility boxes, solenoid packs, vacuum pumps, screwdrivers, cameras, lighting, etc. to the inner link, outer link, or column.
- Attaching hoses, pneumatic lines, or cables to the robot. These should be designed so they do not restrict joint motion or cause robot motion errors.

### Unacceptable Modifications

If not done properly, the modifications listed below will damage the robot, reduce system safety and reliability, or shorten the life of the robot.

**CAUTION:** Making any of the modifications outlined below will void the warranty of any components that Adept determines were damaged due to the modification. You must contact Adept Customer Service if you are considering any of the following modifications.

- Modifying any of the robot harnesses or robot-to-controller cables.
- Modifying any robot access covers or drive system components.
- Modifying, including drilling or cutting, any robot casting.
- Modifying any robot electrical component or PC board.
- Routing additional hoses, air lines, or wires through the robot.

## 1.7 Endangerment Through Additional Equipment

Additional equipment, for instance grippers, conveyor belts, etc. are not allowed to reduce the safeguarding of the workcell.

All Emergency Stop Switches must be always accessible.

If the robot is to be used in an EU or EEA member-country, all components in the robot workcell must comply with the safety requirements in the European Machine Directive 89/392/EEC (and subsequent amendments) and related harmonized European, international, and national standards.

In other countries, Adept strongly recommends a similar level of safety be obtained, in addition to complying with the applicable local and national regulations.

## 1.8 Sound Emissions

The sound level of the AdeptOne-MV, the AdeptThree-MV, and the Adept PackOne-MV Robot exceeds 70dB.

## 1.9 Thermal Hazard

**WARNING:**
Thermal Hazard!
You can burn yourself. Do not touch the robot base or outer link shortly after the robot has been running at high ambient temperatures (40-50°C) at fast cycle times (over 60 cycles per minute). The temperature at the robot can exceed 70°C.

## 1.10 Working Areas

Adept robots have both a Manual and an Automatic operating mode. While in Automatic Mode, no personnel are allowed to stay in the workcell.

In Manual Mode, operators with additional safety equipment (see section 1.13 on page 13) are allowed to work in the robot workcell. For safety reasons the operator should, whenever possible, stay outside of the working envelope of the robot to prevent injury. The maximum speed and power of the robot is reduced but it could still cause injury to the operator.

Before performing maintenance in the working envelope of the robot, High Power must be switched off and the power supply of the robot must be disconnected. After these precautions, a skilled person is allowed to maintain the robot. See section 1.11 on page 12 for the specifications of the personnel.

The AdeptOne-MV, PackOne-MV, and AdeptThree-MV robots can work in Automatic Mode with high speeds and accelerations and can trap persons or can crush them. The impact of a robot can kill a person.

**WARNING:**
Electrical Hazard!
Impact Hazard!
Never remove any safeguarding and never make changes in the system that will de-commission a safeguard.

## 1.11 Qualification of Personnel

This manual assumes that the personnel have attended an Adept training course and have a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.

As noted in this handbook, certain procedures should be performed only by **skilled** or **instructed** persons. For a description of the level of qualification Adept uses the standard terms:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers which electricity may create (engineers and technicians).
- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers which electricity may create (operating and maintenance staff).

All personnel must observe sound safety practices during the installation, operation and testing of all electrically powered equipment. To avoid injury or damage to equipment, always remove power by disconnecting the AC power cord from the source before attempting any repair or upgrade activity.

**WARNING:** The user is obligated to get confirmation from every entrusted person before they start working with the robot about the following subjects:
1.) The person has received the Instruction Handbook, has read it, has understood it and
2.) The person will work in the described manner.

## 1.12 Transport

Always use adequate equipment to transport and lift Adept devices. See Chapter 2 for more information on transporting, lifting, and installing.

**WARNING:** Do not stay under the robot while it is transported.

## 1.13 Safety Equipment for Operators

Adept advises operators to wear extra safety equipment in the workcell. For safety reasons the operators must wear

- safety glasses,
- protective headgear,
- and safety shoes

when they are in the robot workcell. Install warning signs around the workcell to make sure anyone working around the robot system knows they must wear safety equipment.

## 1.14 Protection Against Unauthorized Operation

The system must be protected against unauthorized use. Restrict access to the keyboard and the Manual Control Pendant by locking them in a cabinet or use another adequate method to prevent access to them.

## 1.15 Operating Modes of Adept Robots

The AdeptOne-MV, AdeptThree-MV, and Adept PackOne-MV robot have two different operating modes.

### Automatic Mode

Adept Robot systems are computer-controlled, and the program that is currently running the robot may cause it to move at times or along paths you may not anticipate. When the key switch for the operating mode is in the AUTO position and the HIGH POWER light or the PROGRAM RUNNING light on the external Front Panel (VFP) are illuminated, do not enter the workcell because the robot or motion device might move unexpectedly. (The LAMP TEST button on the VFP allows these lights to be periodically checked.)

**WARNING:** During Automatic Mode operations no person is allowed to stay in the guarded space of the robot, because serious injury or death can occur if a person is struck by the robot.

### Manual Mode

Adept robots can also be controlled manually when the operating mode key switch is in the MANUAL position and the HIGH POWER light on the VFP is illuminated. When Manual mode is selected, motion can only be initiated from the Manual Control Pendant (MCP). Per EN 775/ISO 10218, the maximum speed of the robot is limited to 250 mm per second (10 ips) in Manual mode. In this mode, work that requires close approach to the installation or robot can be performed; such as teaching points, program verification, or troubleshooting operations.

**NOTE:** The MCP has two operating modes. In MAN (Manual) mode the MCP can initiate a robot motion. In COMP (Automatic) mode the MCP works like a terminal.

## 1.16 Safety Aspects While Performing Maintenance

Only skilled persons with the necessary knowledge about the safety and operating equipment are allowed to maintain the robot, controller, and power chassis.

**WARNING:** During maintenance and repair, the power of the Adept PA-4 power chassis and the Adept MV controller must be turned off. Unauthorized third parties must be prevented from turning on power through the use of fail-safe lockout measures. (Turn off the circuit breakers, lock the cabinet and remove the key!).

## 1.17 Risks That Cannot Be Avoided

The Category 3 AdeptOne-MV, AdeptThree-MV, and the Adept PackOne-MV Robot Control system implementation has a series of electro-mechanical devices that disable High Power if a system failure occurs.

The following situations may result in risks that cannot be avoided:

- purposely defeating any aspect of the safety E-Stop system
- improper installation or programming of the robot system
- unauthorized use of cables other than those supplied or use of modified components in the system
- failure of a second device in a redundant safety circuit

Take precautions to ensure that these situations do not occur.

## 1.18 What to Do in an Emergency Situation

Press any Emergency-Stop button (a red push-button on a yellow field) and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use $CO_2$ to extinguish the fire.

## 1.19 How to Get Help

When calling with an equipment-related question, please have the serial number of the robot, controller, and power chassis. The serial numbers are located on the product data labels on each piece of equipment. The serial numbers can also be determined by using the ID command (see the *V+ Operating System User's Guide*).

### In Europe

#### Europe/Germany

Adept Technology maintains a European Customer Service Center in Dortmund, Germany. The phone numbers are:

(49) 231 / 75 89 40 (Monday to Friday, 8:00 to 17:00,CET)
(49) 231/75 89 450 FAX

#### France

For customers in France, Adept Technology maintains a Customer Service Center in Paris, France. The phone numbers are:

(33) 1 69 19 16 16 (Monday to Friday, 8:30 to 17:30, CET)
(33) 1 69 32 04 62 FAX

#### Italy

For customers in Italy, Adept Technology maintains a Customer Service Center in Arezzo, Italy. The phone numbers are:

(39) 575 3986 11 (Monday to Friday, 8:30 to 17:30, CET)
(39) 575 3986 20 FAX

### In the United States

Adept Technology maintains a Customer Service Center at its headquarters in San Jose, CA. The phone numbers are:

#### Service Calls

(800) 232-3378 (24 hours per day, 7 days a week)
(408) 433-9462 FAX

#### Application Questions

(800) 232-3378 (Monday to Friday, 8:00 am to 5:00 pm, Pacific time)
(408) 434-6248 FAX

#### Applications Internet E-Mail Address

If you have access to the Internet, you can send applications questions by e-mail to:

applications@adept.com

#### Training Information

For information regarding Adept Training Courses in the USA, please call (408) 434-5024.

## Outside Continental United States or Europe

For service calls, application questions, and training information, call the Adept Customer Service Center in San Jose, California USA:

1 (408) 434-5000
1 (408) 433-9462 FAX (service requests)
1 (408) 434-6248 FAX (application questions)

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# 2.1 Environmental and Facility Requirements for Robots

The information in this chapter applies to the AdeptOne-MV, the AdeptThree-MV, and the Adept PackOne-MV robots, except where differences are specifically noted.

## Facility Ambient Air Quality For Robots

The following specifications apply to the AdeptOne-MV, AdeptThree-MV, and the Adept PackOne-MV robots.

**Table 2-1. Operating Environment Specifications for Adept Robots**

| | Temperature | Relative Humidity | IP Rating |
|---|---|---|---|
| Standard Robot | 5° to 40° C (41° to 104° F) | 5 to 95% non-condensing | IP 20[a] |
| HyperDrive Robot[b] | 5° to 50° C (41° to 122° F) | 5 to 95% non-condensing | IP 20[a] |
| Cleanroom Robot | 5° to 40° C (41° to 104° F) | 5 to 95% non-condensing | IP 20[a] |
| Cleanroom HyperDrive Robot | 5° to 27° C (41° to 80° F) | 5 to 95% non-condensing | IP 20[a] |
| PackOne-MV | 1° to 45° C (33.5° to 113° F) | 10 to 100% condensing | IP 55[c] |

[a] The IP rating includes the motors inside the robot.
[b] Standard HyperDrive robots have a cooling fan in the base. The fan filter must be kept clean to ensure proper cooling. See page 107.
[c] On the PackOne, the motors inside the robot are IP 20.

### Compressed Air for the AdeptOne-MV and AdeptThree-MV Robot

The AdeptOne-MV and the AdeptThree-MV robots require clean, dry, oil-free compressed air at 5.5 – 7.6 bar (80-110 psi) with a flow rate of 28 liters per minute (1 SCFM). This compressed air is used to release the robot brakes and to provide air to the User air lines. End-effectors attached to the robot may require additional air flow. Insufficient air pressure or flow will cause the brakes to engage, which will disable High Power.

**CAUTION:** Failure to supply clean, dry, oil-free air may result in damage to mechanical, electrical, and pneumatic components inside the robot.

### Additional Facility Requirements of the Adept PackOne-MV Robot

The Adept PackOne-MV robot requires clean, dry, oil-free compressed air at 5.5 – 7.6 bar (80-110 psi) with a flow rate of 170 liters per minute (6 SCFM). The Adept PackOne-MV robot uses compressed air for internal condensation protection. The design of the internal air flow is an important feature of the Adept PackOne because it helps to eliminate internal condensation and evaporate any moisture that gets inside.

**CAUTION:** Insufficient air pressure or flow will allow the brakes to engage and disable High Power. Compressed air must be supplied to the robot 24 hours per day. Failure to supply air to the robot 24 hours per day can void the warranty.

The compressed air source must be equipped with a refrigerated or desiccant type air dryer that can achieve an air dew point (at 5.5 bar) 17°C (30°F) below the minimum ambient temperature. For example, if the robot operates in a 10°C cold room, the compressed air dew point must be -7°C (20°F) maximum. If a desiccant type dryer is used, it should be an automatically recharging type, with a large enough capacity so it requires minimal servicing.

The Adept PackOne-MV robot has an air filter and moisture trap on its inlet air fitting. If clean, dry air is not available, *additional user-supplied filtering is required*. The air connection inlet is a 1/4-inch Industrial Interchange nipple located at the air filter at the base of the robot.

## Mounting Surface Specifications

The floor at the installation site must be concrete with a minimum thickness of 100 mm and must comply with all local codes. The floor should be level. Due to the very high torque (more than 270 Nm [200 ft-lb] at the base) transmitted by the robot, it *must* be mounted to an extremely rigid structure. Any mounting structure vibration or flexing will seriously degrade robot performance. Adept recommends using either a mounting plate or a mounting spool. Both have proven reliable over extended periods of use. If another type of mounting structure is used, it must adequately resist vibration and flexure.

**NOTE:** Mounting the base on a surface other than the recommended steel plate (or spool) may make robot recalibration difficult. Make robot recalibration as easy as possible by designing a workcell that allows for mounting of the calibration fixture without extensive dismantling of the workcell. See Figure 6-4 on page 117 for a drawing and dimensions of the calibration fixture.

### Plate

Using a flat steel plate is mandatory if the robot is to be mounted directly to the facility floor. The mounting plate should conform to the following recommended specifications:

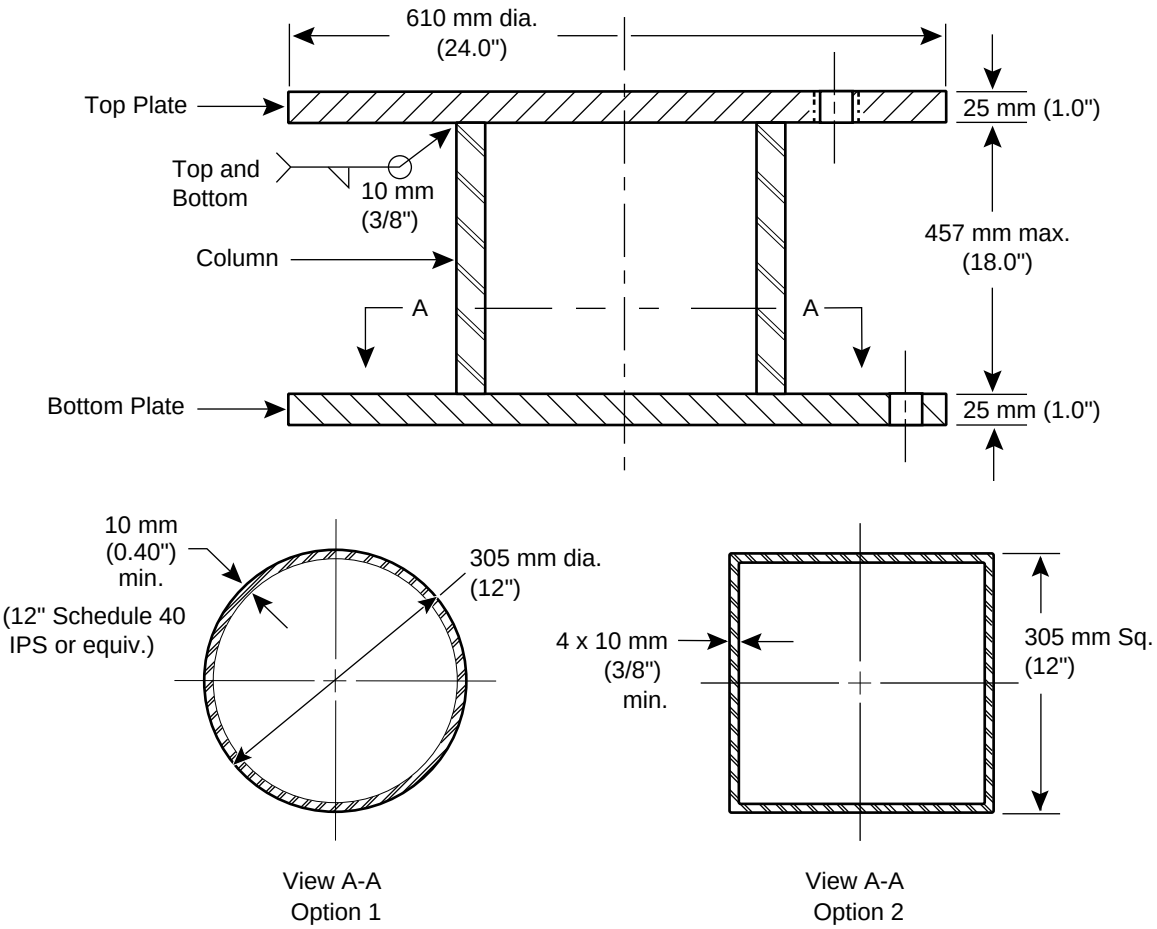
- Material: carbon steel
- Diameter: 610 mm (24.0 inches)
- Thickness: 25 mm (1.0 inch)
- Mounting surface flatness: within 0.5 mm (0.02 inch)
- Mounting hole pattern: as shown in Figure 2-3 and Figure 2-4
- Mounting surface level: must be level to within **±0.25 degrees** (±2.5 mm [0.1 in.] for a 610 mm [24 in.] spool)

**WARNING:** The specification for leveling the mounting surface is critical on Category 3 systems because the Teach Restrict sensor in the outer link will not function otherwise.

### Spool

Another method of mounting uses a spool. Refer to Figure 2-1 for the specification and dimensions of a robot spool. All of the specifications for the mounting plate in the previous section apply to the top plate of the mounting spool.

The recommended design for a manufactured spool is a welded assembly consisting of three steel parts: top and bottom plates welded to a center column, as detailed in Figure 2-1.




- Material: Carbon Steel • Mounting Surface Flatness: 0.5 mm (0.02")
- Mounting Surface Level: within ±**0.25**° (±2.5 mm [0.01"] over 610 mm [24"] diameter)

**Figure 2-1. Recommended Mounting Spool Specifications**

## 2.2 Environmental and Facility Requirements for Controller

The Adept MV controller installation must meet the operating environment requirements shown in Table 2-2. See Table 2-5 on page 54 for electrical requirements.

**Table 2-2. Operating Environment Requirements**

| | |
|---|---|
| Ambient temperature | |
| controller – while accessing floppy or hard drive | 5°C to 40°C (32 to 104°F) |
| controller – while not accessing floppy or hard drive | 5°C to 50°C (32 to 122°F) |
| power chassis | 5°C to 40°C (32 to 104°F) |
| Humidity | 5 to 90%, non-condensing |
| Altitude | up to 2000 m (6500 ft.) |
| Pollution degree | 2 |
| Free space around controller and power supply (for proper cooling) | 50 mm (2") in front, 25 mm (1") at top |
| Sub-assembly protection class, unmounted | IP20 (NEMA Type 1) |
| Requirements for customer-supplied enclosure with Adept controller and power chassis mounted inside enclosure. | Enclosure must meet EN 60204 requirements and be rated at IP54. Also, enclosure must provide a method of locking the enclosure power-disconnect in the OFF position. |

## 2.3 Environmental and Facility Requirements for Power Chassis

The Adept PA-4 power chassis is typically installed in the same enclosure as the controller. See Table 2-2 for environmental requirements. See Table 2-7 on page 56 for electrical requirements.

## 2.4 Before Unpacking the Adept Equipment

Carefully inspect all shipping crates for evidence of damage during transit. Pay special attention to tilt and shock indication labels on the exteriors of the containers. If any damage is indicated, request that the carrier's agent be present at the time the container is unpacked.

## 2.5 Adept Shipment Specifications

Adept ships the equipment in a number of boxes and shipping crates, depending on the order. The boxes have different dimensions and weights. The following table gives an overview.

**Table 2-3. Adept Shipping Crate Specifications**

| Product in Crate | Length | Width | Height | Weight |
|---|---|---|---|---|
| AdeptOne-MV Robot | 0.74 m (29 in.) | 1.20 m (47 in.) | 1.78 m (70 in.) | 220 kg (484 lb) |
| AdeptThree-MV Robot | 0.74 m (29 in.) | 1.20 m (47 in.) | 2.00 m (79 in.) | 240 kg (528 lb) |
| Adept PackOne-MV Robot | 0.74 m (29 in.) | 1.20 m (47 in.) | 1.78 m (70 in.) | 275 kg (605 lb) |
| Adept MV Controller and PA-4 Power Chassis | 0.89 m (35 in.) | 0.64 m (25 in.) | 0.96 m (38 in.) | 66 kg (145 lb) |
| Monitor | 0.54 m (21 in.) | 0.51 m (20 in.) | 0.51 m (20 in.) | 23 kg (50 lb) |

**WARNING:** The center of gravity of the robot shipping crates is not in the middle of the boxes. Pay attention when you transport the crates.

## 2.6 Transport and Storage

For the transport and storage of the crates and boxes use a adequate tool, for instance a pallet jack or a fork lift. See Figure 2-2.

**WARNING:** Heavy load!
Do not attempt to transport the robot boxes by hand. Always use a pallet jack, fork lift, etc.

The robots must be always stored and shipped in an upright orientation. Do not lay the crate on the side or another position. A different position other than standing on the robot base could damage the robot.

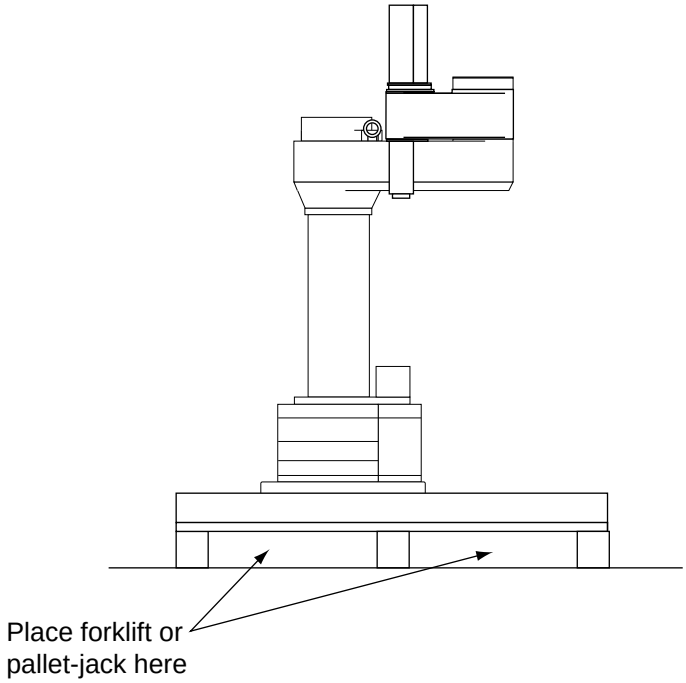



**Figure 2-2. Adept Robot on a Transportation Pallet**

## 2.7 Unpacking and Inspecting the Adept Equipment

Compare the actual items received (not just the packing slip) with your equipment purchase order and verify that all items are present and that the shipment is correct.

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact Adept at the numbers listed at the end of Chapter 1.

Retain all containers and packaging materials. These items may become necessary to settle claims or, at a later date, to relocate equipment.

## 2.8 Repackaging For Relocation

If the robot or other equipment needs to be relocated, reverse the steps in the installation procedures that follow this section. Re-use all original packing containers and materials and follow all safety notes used for installation. Improper packaging for shipment will void your warranty. Before unbolting the robot from the plate or spool, fold the outer arm against the Joint 2 hardstops to help centralize the center of gravity. The robot must always be shipped in an upright orientation; specify this to the carrier if the robot has to be shipped.

## 2.9 Robot Installation

Adept robots must always be installed on a base. A base could be a mounting plate or a mounting spool. It is not allowed to install a robot directly on the floor.

### Tool and Equipment Requirements

Common hand tools, plus the following items, are required to install the robot and any options or end-effectors:

- Drill motor, 1/2 inch drive
- Masonry bit, 7/8 inch (22 mm)
- Ratchet handle, 1/2 inch drive
- Socket, 3/4 inch
- Spirit level
- Torque wrench, 1/2 inch drive
- Vacuum cleaner
- Pallet jack (or forklift)
- Hydraulic lift with dual-leg sling (both rated for 320 kg [700 pounds] minimum)
- Mounting plate or spool

**WARNING:** The installation procedures in this chapter should only be performed by skilled persons, as defined in section 1.11 on page 12.

## Installing a Base for the Robot

Adept recommends that you follow the given instructions for the installation of a mounting plate or a mounting spool, see page 20. Figure 2-3 shows the mounting hole pattern of the robot for an installation on a mounting plate or mounting spool.

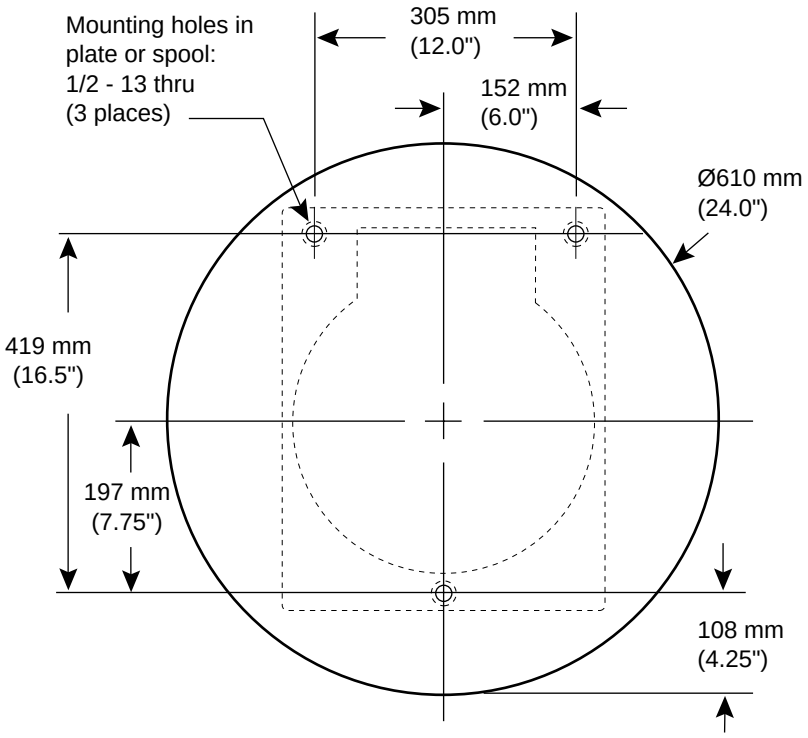



**Figure 2-3. Mounting Hole Pattern (Robot-to-Plate/Spool)**

### Installing a Mounting Plate

The following sequence details the installation of a robot-mounting plate to the floor. (See Figure 2-5.)

**NOTE:** You can substitute M12 bolts of correct length in place of 1/2-13 bolts to install mounting plate and robot.

1. Drill and tap three 1/2-13 UNC-2B mounting holes, as shown in Figure 2-3, for robot-to-plate attachment.

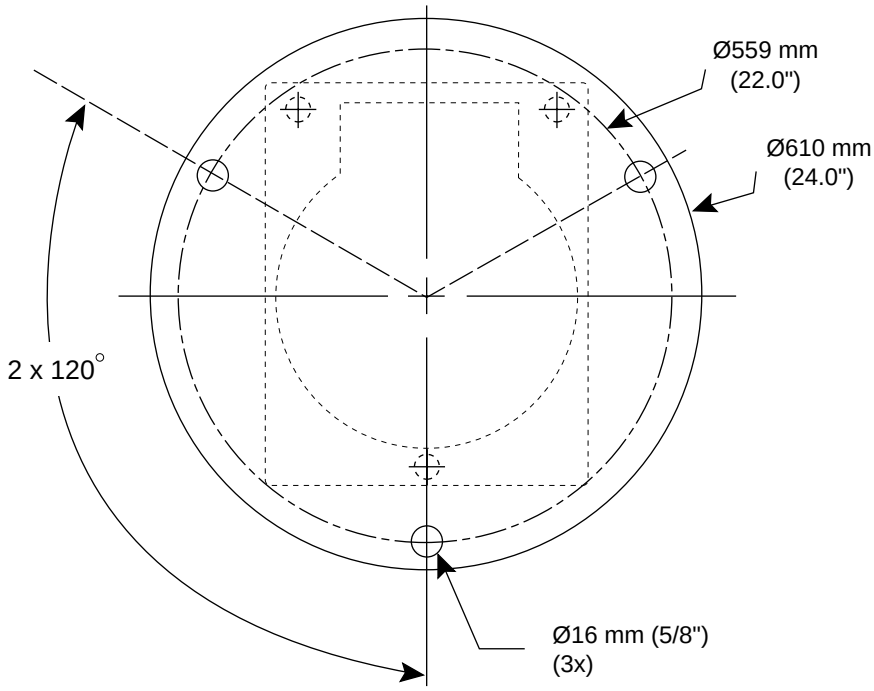



**Figure 2-4. Mounting Hole Pattern (Plate/Spool-to-Floor)**

2. Drill three 16 mm diameter through holes, as shown in Figure 2-4, for plate-to-floor anchoring.
3. Place the plate exactly where the robot is to be installed. Ensure that the plate is positioned so that the "footprint" for the robot is properly oriented relative to the workcell. Using the plate as a template, transfer the locations of the three plate-to-floor mounting holes directly to the floor.
4. Set the plate aside and drill three holes, 22 mm (7/8 inch) in diameter by 90 mm (3.5 inches) deep, in the floor at the locations identified in step 3.

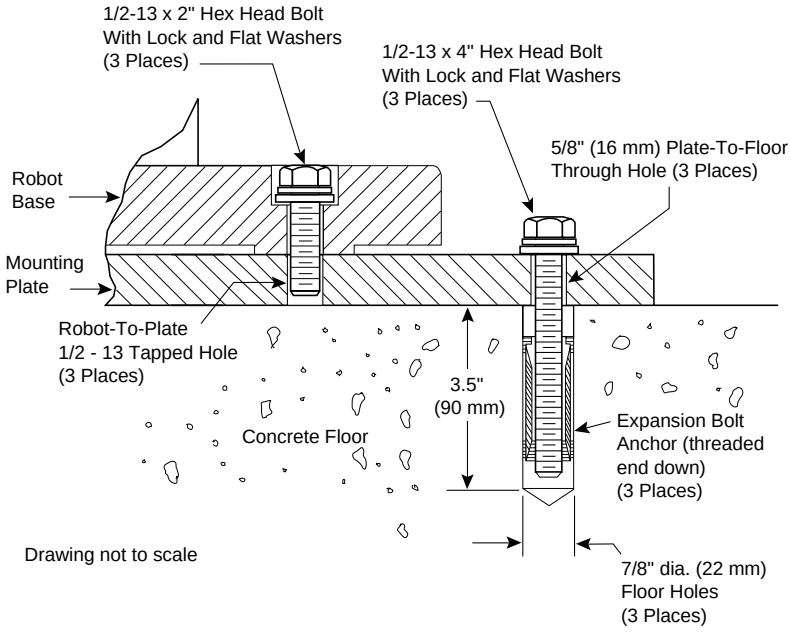



**Figure 2-5. Mounting Plate-to-Floor Installation Detail**

5. Using a vacuum cleaner, remove all chips and debris from the holes (and surrounding area) drilled in step 4.
6. Insert an expansion bolt anchor into each of the three holes in the floor. Ensure that the threaded end of each bolt anchor is toward the bottom of each hole, as shown in Figure 2-5.
7. Reposition the plate over the anchor holes in the floor using care to align the three plate-to-floor holes with the anchor holes. Ensure that the plate is positioned so that the "footprint" for the robot is properly oriented to the workcell.
8. Using a spirit level, verify that the top (mounting) surface of the plate is level. The surface must be horizontal within ±0.25 degrees. If the plate is not level, insert shims between the plate and the floor to bring the plate within specifications. The shims should be at least 75 mm in diameter and have cutouts provided to fit around the anchor bolts.
9. Insert a 1/2-13 x 4 inch bolt, fitted with a lock washer and a flat washer, through the holes in the plate into each of the three plate-to-floor anchor holes. Tighten the bolts to 54 Nm (40 ft-lb) of torque.
10. Re-check the robot mounting surface of the plate using the spirit level and re-shim as required to bring the mounting surface horizontal within ±0.25 degrees.

### Installing a Mounting Spool

The following sequence details the installation of the robot-mounting spool to the floor. (See Figure 2-6.)

> **NOTE:** You can substitute M12 bolts of correct length in place of 1/2-13 bolts to install mounting spool and robot.

1. Drill and tap three 1/2-13 UNC-2B mounting holes (through), as shown in Figure 2-3, for robot-to-spool attachment.
2. Prepare the opposite flange of the mounting spool by drilling three 16 mm (5/8-inch) diameter through holes, as shown in Figure 2-6, for spool-to-floor anchoring.
3. Place the spool exactly where the robot is to be installed. Ensure that the spool is positioned so that the footprint for the robot is properly oriented to the workcell. Transfer the locations of the three spool-to-floor mounting holes directly to the floor.
4. Set the spool aside and drill three holes, 22 mm (7/8 inch) in diameter by 90 mm (3.5 inch) deep, in the floor at the locations identified in step 3.
5. Using a vacuum cleaner, remove all chips and debris from the holes (and surrounding area) drilled in step 4.
6. Insert an expansion bolt anchor into each of the three holes in the floor. Ensure that the threaded end of each bolt anchor is toward the bottom of each hole, as shown in Figure 2-6.
7. Reposition the spool over the anchor holes in the floor taking care to align the three spool-to-floor holes with the anchor holes. Ensure that the spool is positioned so that the "footprint" for the robot is properly oriented to the workcell.
8. Using a spirit level, verify that the top (mounting) surface of the spool is level. The surface must be horizontal within ±0.25 degrees. If the spool is not level, insert shims between the spool and the floor to bring the spool within specifications. The shims should be at least 75 mm (3 inches) in diameter and have cutouts provided to fit around the anchor bolts.
9. Insert a 1/2-13 x 4 inch bolt, fitted with a lock washer and a flat washer, through the holes in the spool into each of the three spool-to-floor anchor holes. Tighten the bolts to 54 Nm (40 ft-lb) of torque.
10. Re-check the robot-mounting surface of the spool using the spirit level and re-shim as required to bring the mounting surface horizontal within ±0.25 degrees.

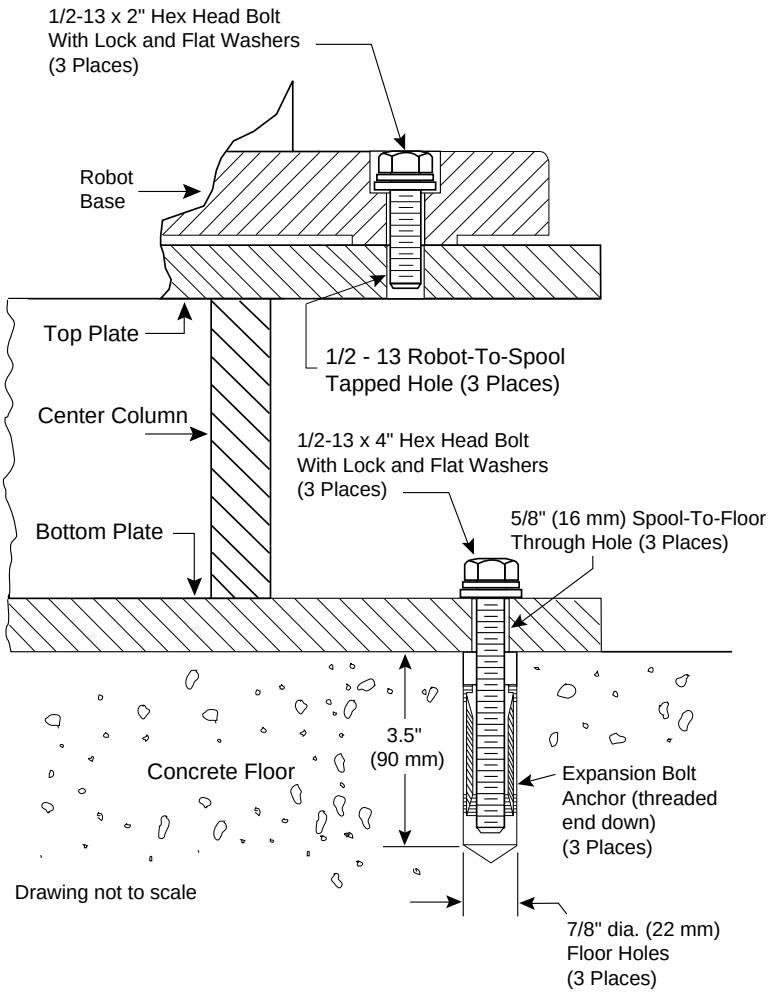



**Figure 2-6. Mounting Spool-to-Floor Installation Detail**

## Installing a Robot on a Base

The following sequence describes the installation of the robot to the mounting plate or spool.

**NOTE:** You can substitute M12 bolts of correct length in place of 1/2-13 bolts to install mounting spool and robot.

1. Connect the hydraulic lift to the eyebolts at the top of the robot by means of the dual-leg sling, see Figure 2-7. Take up any slack but do not lift the robot at this time.

**WARNING:** Impact Hazard
Do not attempt to lift the robot at any points other than the eyebolts provided. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

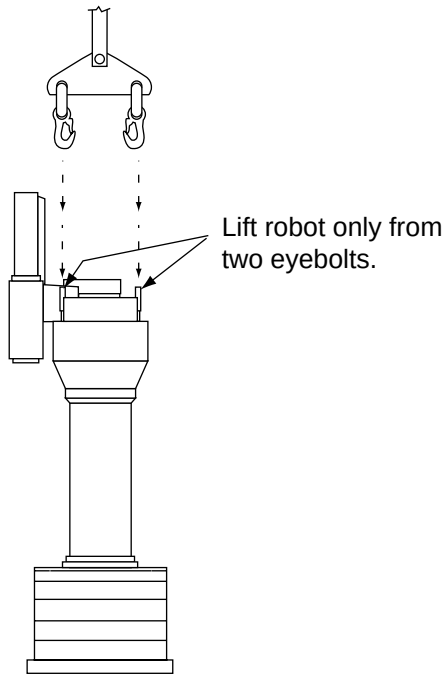



**Figure 2-7. Lifting Robot From Eyebolts**

2. Remove the three bolts securing the robot base to the pallet. Retain these bolts for possible later relocation of the equipment.

**WARNING:** Do not attempt to extend the inner or outer links of the robot until the robot has been secured in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

3. Lift the robot and position it directly over the floor plate or spool.

**WARNING:** Impact Hazard
The robot may swing free if not lifted straight up. Stand clear of the robot at all times while it is supported by the lift.

4. Slowly lower the robot while aligning the base and the tapped mounting holes in the plate or spool.
5. Insert a 1/2-13 x 2 inch bolt (3.5 inch for PackOne) fitted with both a lock washer and a flat washer through each of the three mounting holes in the robot base into the mounting plate or spool and torque to 88 Nm (65 ft-lb).

# 2.10 Installation of the Adept MV Controller and the Adept PA-4 Power Chassis

## Joining an Adept PA-4 Power Chassis to an Adept MV Controller

The Adept PA-4 power chassis can be joined to the Adept MV-8 (or MV-19) controller using the brackets supplied in the accessory kit. They must be joined at the top *and* bottom, as described in the following paragraphs.

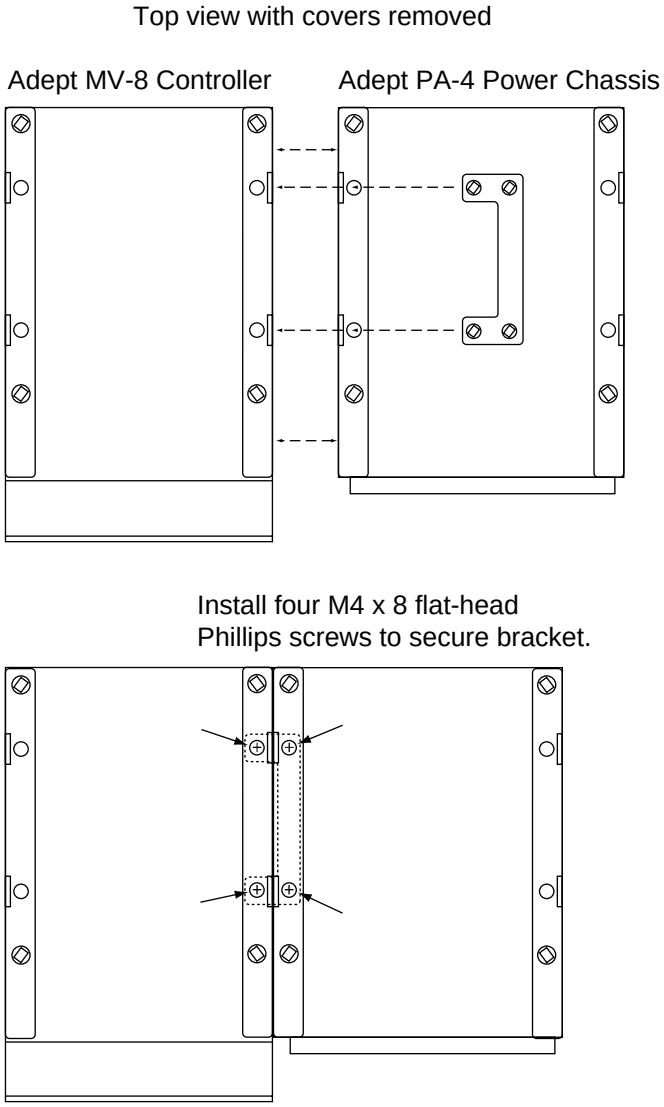

Top view with covers removed
Adept MV-8 Controller
Adept PA-4 Power Chassis
Install four M4 x 8 flat-head
Phillips screws to secure bracket.

**Figure 2-8. Joining the Power Chassis and Controller at the Top**

### Joining at the Top

1. Turn off power to each unit and disconnect the power cord. Place the two units next to each other. Remove the top cover from both. See Figure 2-8
2. Locate the C-shaped bracket in the accessory kit.
3. Slip the bracket under the lip of the top edge of the unit on the right-hand side and into the two slots in the edge of the chassis. Install two M4 x 8 flat head screws into the lip and down into the bracket.
4. Install the other two M4 x 8 flat head screws into the chassis on the left-hand side. Replace the cover on each unit.

### Joining at the Bottom

1. Turn the two units over so you have access to the bottom side.
2. Locate the cutout bracket in the accessory kit.
3. Place the bracket over the feet of the units as shown in Figure 2-9.
4. Install the four M4 x 8 flat head screws in the holes indicated in Figure 2-9 to secure the brackets.

**CAUTION:** Do not use screws longer than 8 mm to install the bracket. Doing so could cause damage to your equipment.

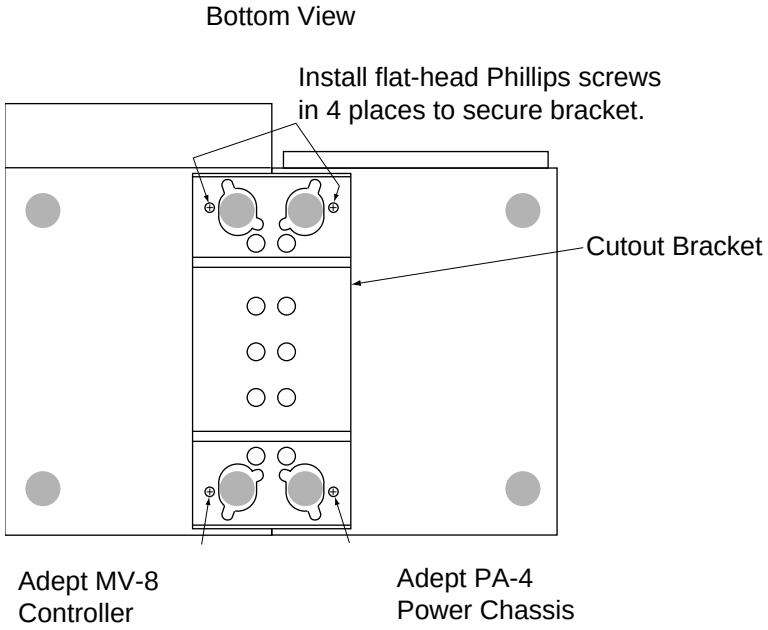



**Figure 2-9. Joining the Power Chassis and Controller at the Bottom**

## Space Around the Chassis

When the controller and power chassis are installed, you must allow 50 mm (2 inches) at the front of each chassis and 25 mm (1 inch) at the top of each chassis for proper air cooling.

**CAUTION:** It is important to keep the air filters clean so the forced air cooling system can work efficiently. See section 5.6 on page 107 for details on cleaning the filters.

## Installation in a Rack or Panel Mount

The power chassis and controller can be mounted in a rack or panel by using the mounting brackets that are shipped in the accessories kit. The brackets can be attached at the rear of the controller/power chassis for panel mounting or they can be attached to the front of the controller/power chassis for rack mounting.

### Panel Mounting

To panel mount the controller or power chassis, install one bracket on each side near the back of the chassis. Use the screws and washers from the accessories kit. See Figure 2-10 and Figure 2-11.

### Rack Mounting

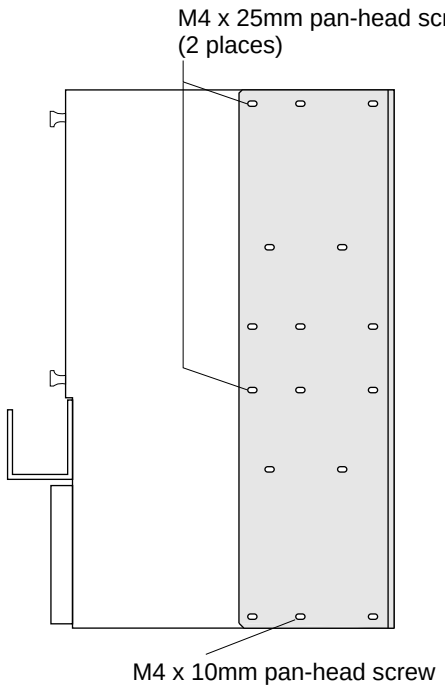
To rack mount the Adept PA-4 power chassis joined to an Adept MV-8 controller in a standard 19-inch equipment rack, you must use the mounting brackets, screws, and washers from the accessories kit. The brackets can be installed in two positions for rack mounting: flush and set-back. See Figure 2-10 and Figure 2-11.

To rack mount the controller or power chassis by itself in a standard 19-inch equipment rack, you must first install the mounting brackets, then build an extender panel and attach it to the bracket on one side of the chassis.

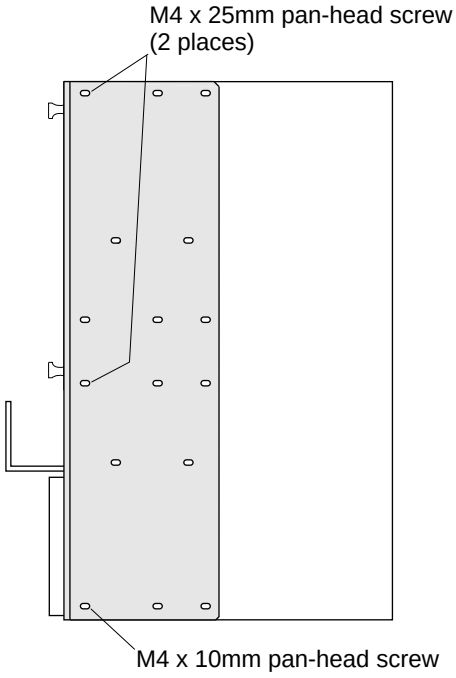
To Install Mounting Brackets on **Adept MV controller**:

- Remove (and discard) 3 existing countersunk screws from side of chassis at locations shown in drawing.
- Place bracket in desired position and secure with indicated M4 screws and washers from accessories kit.
- Repeat process for other side of controller. If the controller is joined to an Adept PA-4 Power Chassis, the position of the screws is different on the side of the controller. See the drawing for the power chassis.

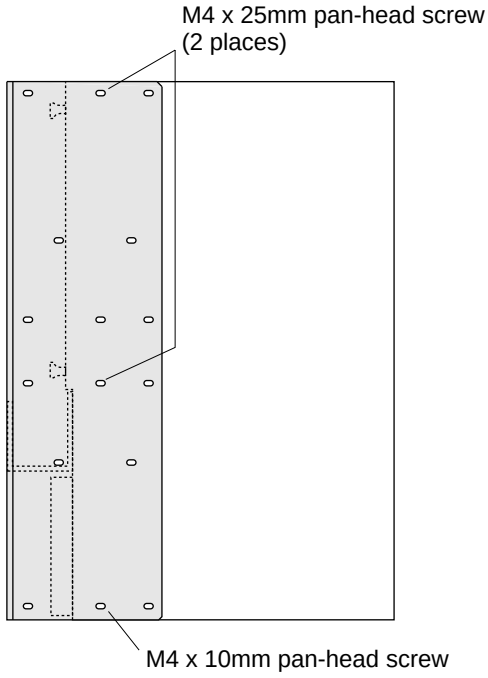
Note: See Figure 6-12 on page 125 for dimensions of the controller and mounting brackets.




**Panel Mount**




**Rack Mount – Flush**



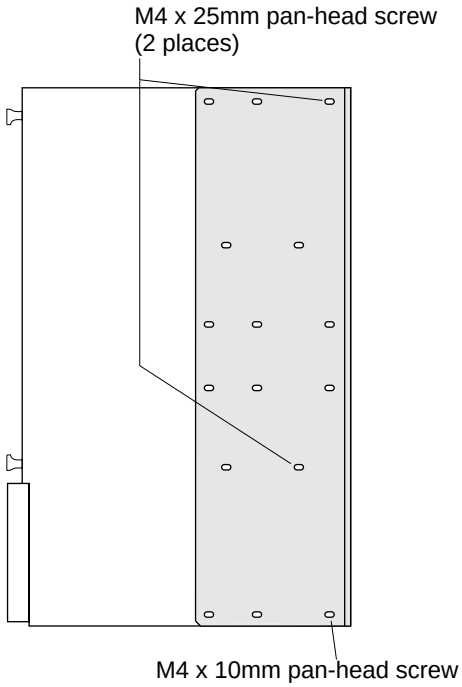

**Rack Mount – Set-Back**

**Figure 2-10. Installing Mounting Brackets on an Adept MV Controller**

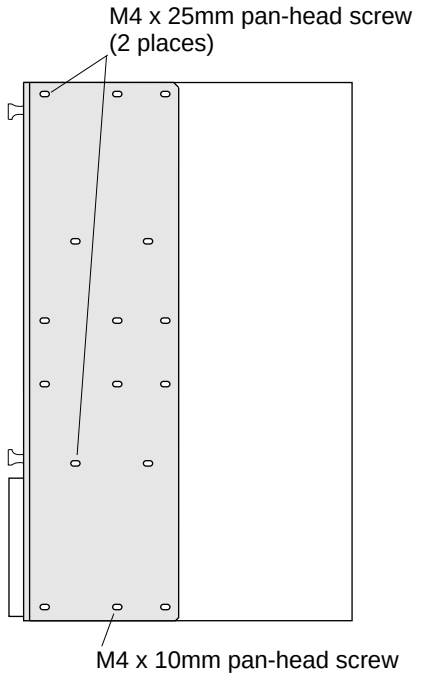
To Install Mounting Brackets on **Adept PA-4 Power Chassis**:

- Remove (and discard) 3 existing countersunk screws from side of chassis at locations shown in drawing.
- Place bracket in desired position and secure with indicated M4 pan-head screws and washers from accessories kit.
- Repeat process for other side of chassis. If the power chassis is joined to an Adept MV controller, the position of the screws is different on the side of the controller. See the controller drawing.

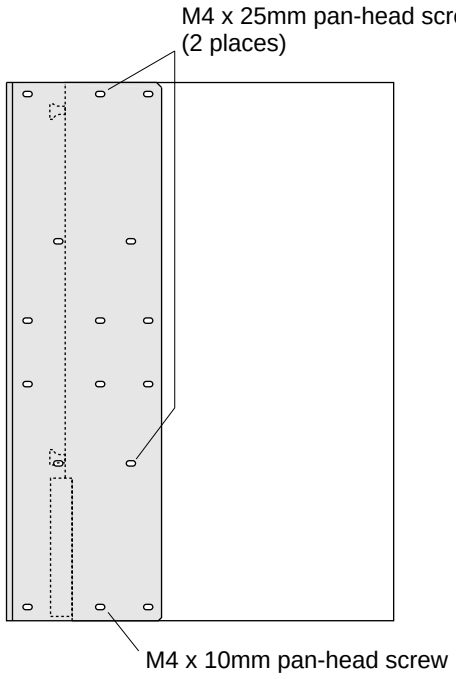
Note: See Figure 6-12 on page 125 for dimensions of the chassis and mounting brackets.




**Panel Mount**




**Rack Mount – Flush**




**Rack Mount – Set-Back**

**Figure 2-11. Installing Mounting Brackets on an Adept PA-4 Power Chassis**

## 2.11 Installing the A-Series Monitor and Keyboard

**NOTE:** The peripheral equipment such as the keyboard and monitor supplied by Adept are intended for use in light industrial conditions. In more severe conditions, they should be protected with a suitable enclosure.

### Installation Procedure

An A-Series Adept MV controller can be configured with a color monitor and an extended keyboard with built-in trackball. Both of these devices connect to the VGB module.

The terminal, monitor and/or keyboard should be mounted at least 0.2 m (0.7 ft) above the floor or other servicing level. (This is mandatory if the installation is in an EU or other country that requires compliance with EN 60204.)

See Figure 2-12 for details; the steps are listed below.

1. Make sure the controller is turned off before making any connections.

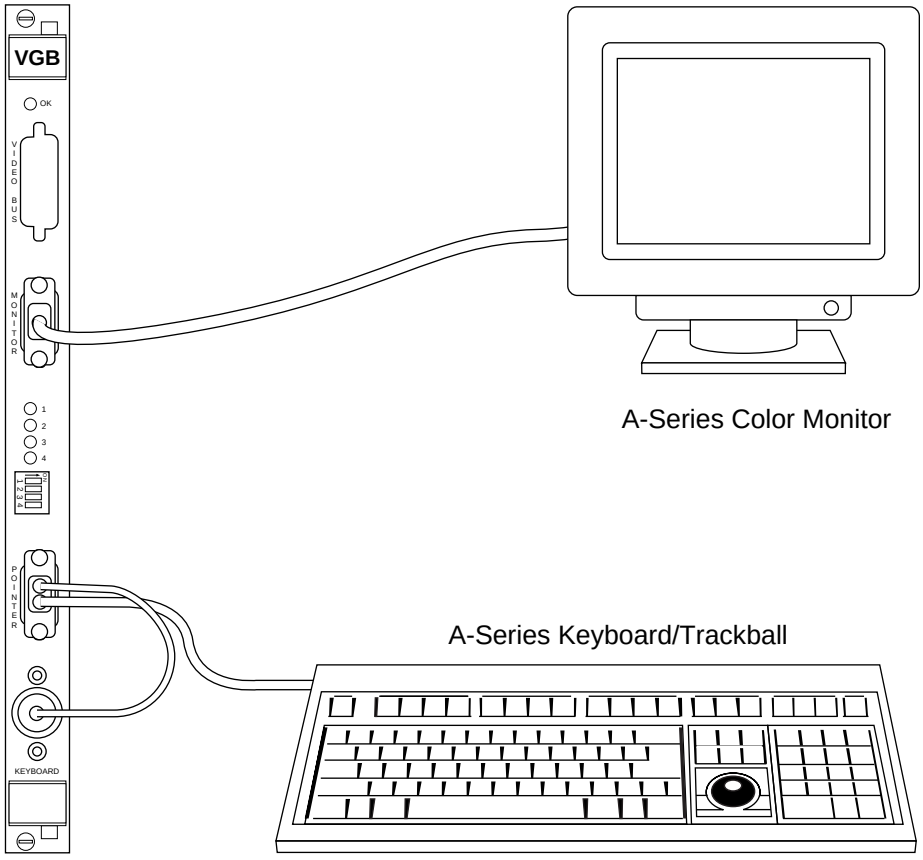



**Figure 2-12. Connecting the A-Series Monitor and Keyboard**

2. Connect the monitor signal cable to the MONITOR connector on the VGB module.

3. Connect the double-ended keyboard cable to the KEYBOARD connector and the POINTER connector on the VGB module.
4. Verify the voltage range marked on the monitor is compatible with your local voltage source. Connect the color monitor AC power cord to the monitor, then plug it into an appropriate voltage source.

## 2.12 Installing a Terminal in an S-Series System

With an S-Series Adept MV controller system, the customer must supply the terminal and cable to interface to the controller. The terminal must be a Wyse Model 60 or 75 with an ANSI keyboard, or a compatible terminal. You may also be able to use a computer with suitable terminal emulation software. For DOS or Windows-compatible computers, the programs "Procomm+" or "Procomm for Windows" (available from many computer stores) include software emulation for the Wyse-75.

### Recommended Terminal for S-Series Systems

The recommended terminal for use with the Adept MV controller is the Wyse WY-60. You must also specify that you require the Wyse ANSI/VT100 style keyboard (Wyse p/n 900127-02 or 900128-02). Note: The WY-60 is also available with ASCII and IBM Enhanced PC keyboards. These are *not* Adept-compatible. You must make sure you order the correct keyboard. The WY-60 is available in both 220V and 110V configurations.

### Installation Procedure

The terminal, monitor and/or keyboard should be mounted at least 0.2 m (0.7 ft) above the floor or other servicing level. (This is mandatory if the installation is in an EU or other country that requires compliance with EN 60204.)

1. Make sure the controller is turned off before making any connections.
2. Verify the voltage range marked on the terminal is compatible with your local voltage source. Connect the AC power cord to the terminal, then plug it into an appropriate voltage source.
3. Connect a suitable serial cable between the terminal and the RS-232/TERM connector on the System Processor module.
4. If the terminal is a Wyse 60, use the setup mode to set the personality to "WY-75". If you are using terminal emulation software on a computer, set the software to "WY-75" emulation. If "WY-75" is not available, try "VT102" or "VT100", but you will not be able to use all of the function keys.
5. Set the terminal baud rate to 9600, that is the default rate for the Adept system. To change the baud rate, refer to the information on CONFIG_C in the *Instructions for Adept Utility Programs*.

## 2.13 Installing the External Front Panel

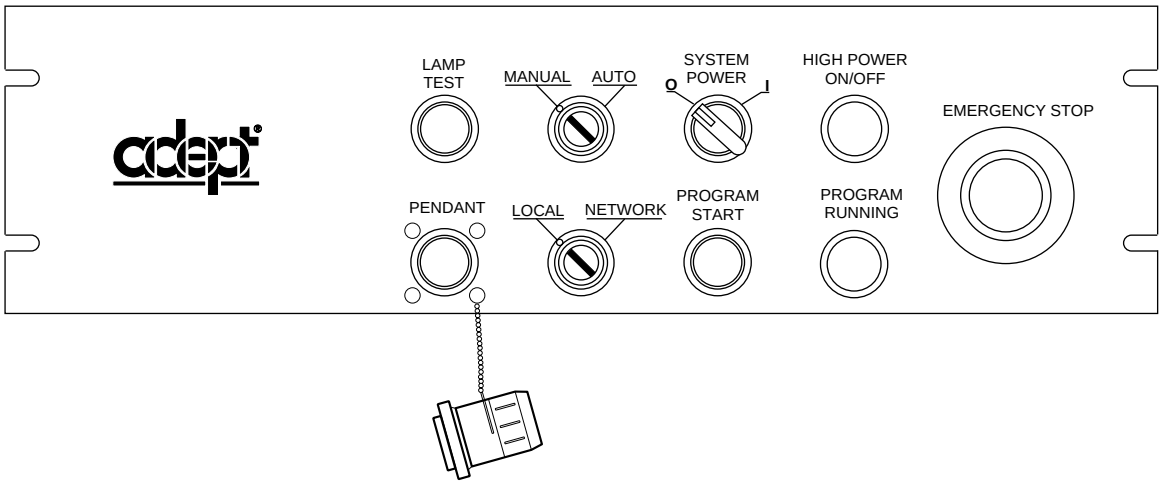



**Figure 2-13. External Front Panel (VFP)**

### Controls and Indicators

- **EMERGENCY STOP switch:** This push-pull emergency stop switch removes HIGH POWER and brings any installed motion device to an immediate stop when pressed.
- **HIGH POWER ON/OFF switch and lamp (amber):** This push-button switch works in conjunction with the Enable Power command. When flashing, this lamp signals the operator to press the button to enable High Power[1]. If the amber lamp is on, the robot is operating under servo control with the brakes released. When the lamp is on, pressing the button engages the brakes, then disables High Power.
- **PROGRAM RUNNING lamp (white):** When lit, this lamp indicates that a $V^+$ program is running. It is a warning that the robot and other mechanisms in the workcell are under computer control and may move at any time.
- **SYSTEM POWER switch and lamp (green):** This rotary on/off switch controls the main AC power relay. The green lamp is lit when main AC power is on.
- **PROGRAM START switch and lamp (green):** A programmer can read the status of the button to trigger special events.
- **Operating Keyswitch:** The keyswitch is a 2-position rotary switch marked AUTO and MANUAL. This switch determines which operating mode is selected. The AUTO position permits control of the system from the controller. The MANUAL position makes the MCP the single point of control.

[1] The lamp flashes for a predetermined time (10 seconds). If the button is not pressed, the request is canceled and High Power is not enabled. The time-out duration can be changed using the CONFIG_C utility.

- **Control Keyswitch:** The keyswitch is a 2-position rotary switch marked LOCAL and NETWORK. This switch determines which device is able to start robot motions. The LOCAL position makes the Manual Control Pendant (MCP) or the connected Terminal the single point of control. The NETWORK position is used with host supervisory control software.
- **LAMP TEST switch:** When the button is pressed, all the indicator lamps should light. If an indicator does not light, check it before continuing operation.
- **PENDANT:** connector for attaching the Manual Control Pendant (MCP) to the front panel. In order to enable High Power, either the MCP or the supplied pendant jumper plug must be connected.

## Installing the External Front Panel (VFP)

The VFP can be mounted in a standard 19-inch equipment rack. See Figure 6-10 on page 123 for dimensions. Since the back of the VFP is open, make sure that it is securely mounted and that electronic components on the back side of the panel are protected from contact by users or other equipment. Mount the VFP in the same enclosure as the controller, or in a separate, protected enclosure. See Table 2-2 for enclosure requirements.

Mount the VFP in a location giving clear view of the robot cell. This will allow the operator to check that no personnel are inside the cell, for example, before enabling power in AUTO mode. In particular, the VFP should be mounted between 0.4 m (1.3 ft) and 2.0 m (6 ft) above the floor or other servicing level. (This is mandatory if the installation is in an EU or other country that requires compliance with EN 60204.) See Figure 2-14 as you perform the following procedure.

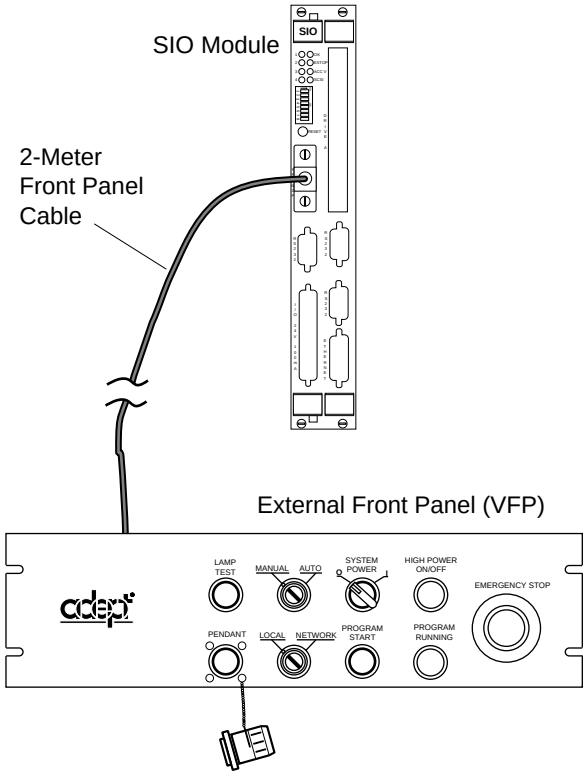



**Figure 2-14. External VME Front Panel Installation**

1. Turn off the Adept MV controller power switch.
2. Remove the FP/MCP bypass plug from the FP/MCP connector on the SIO module.
3. Locate the 2-meter Front Panel cable that comes with the VFP. Plug one end into the FP/MCP connector on the SIO module. Plug the other end into the 26-pin D-Sub connector on the back of the VFP. Tighten the thumbscrews on both connectors.
4. If you are not using an MCP, install the MCP bypass plug in the MCP connector of the VFP. If you are using an MCP, refer to page 46
5. Connect the cable between the VFP and the Security panel, see page 49.

## 2.14 Installation of the Adept Security Panel

### Enclosure Requirements

See Table 2-2 for enclosure requirements.

### Installation of the Security Panel

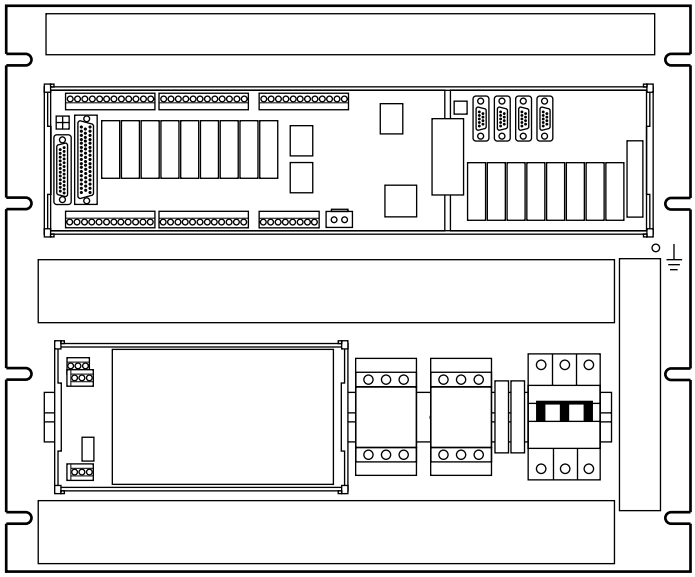


**Figure 2-15. Security Panel**

Adept recommends mounting the Security Panel in the enclosure of the Adept MV controller, or in a separate, protected enclosure that fulfills the requirements. See Figure 6-11 on page 124 for the dimensions of Security Panel.

## 2.15 Signal Interconnection Installation

### System Cable Connections

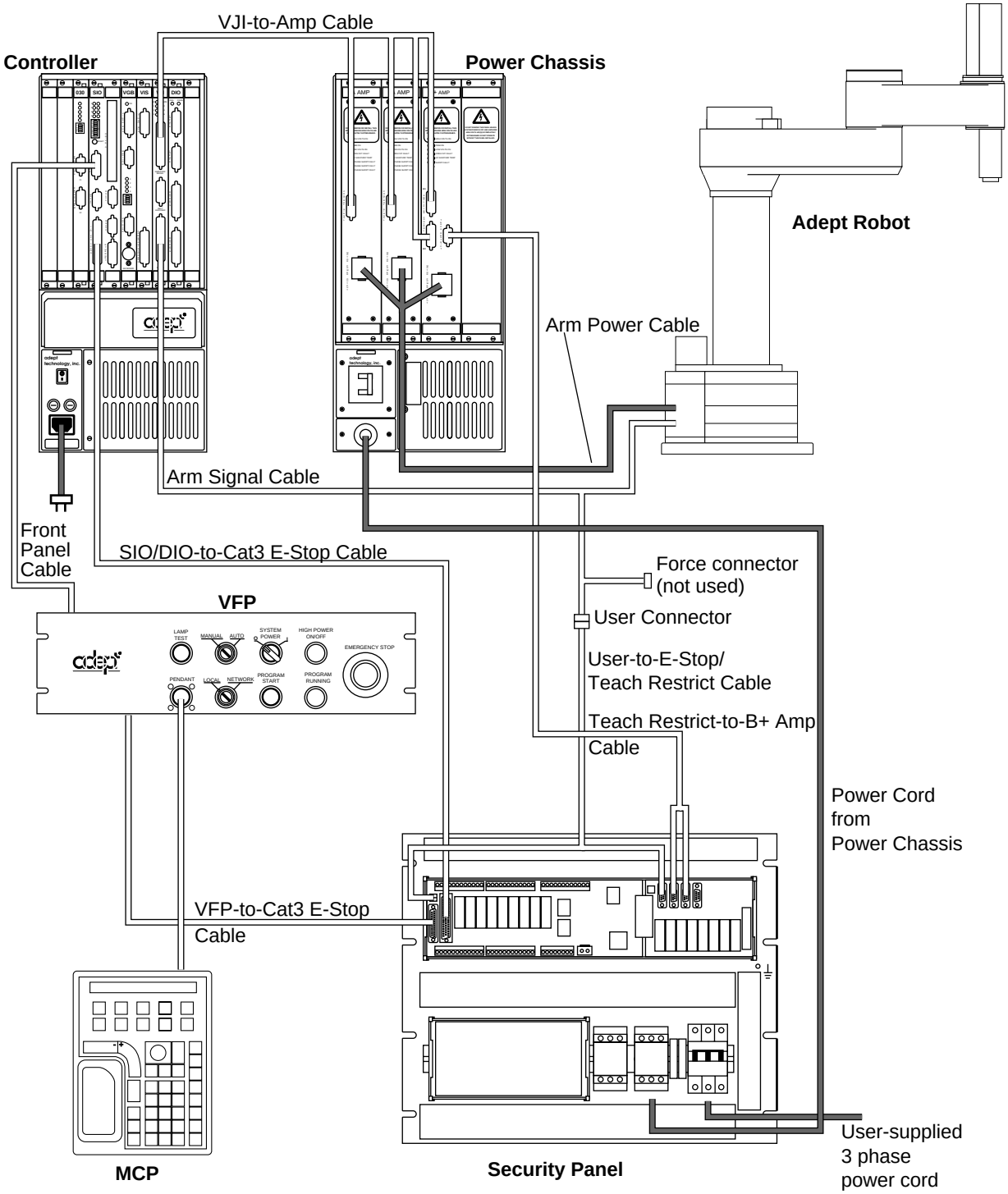



**Figure 2-16. AdeptOne-MV and AdeptThree-MV System Cable Installation**

## System Cable Lengths

**Table 2-4. System Cable Lengths**

| Cable | Length |
|---|---|
| Arm Power and Arm Signal | Standard 4.57 m (15 ft)<br>Optional 7.62 m (25 ft) and 15.24 m (50 ft) |
| VJI-to-Amp | MV-8 = 0.9 m (3 ft), MV-19 = 2.1 m (7 ft) |
| SIO/DIO-to-Cat3 E-Stop | 3.05 m (10 ft) |
| VFP-to-Cat3 E-Stop | 3.05 m (10 ft) |
| User-to-E-Stop/Teach Restrict | 1.8 m (6 ft) |
| Teach Restrict-to-B+ Amp | 1.8 m (6 ft) |
| Front Panel (SIO-to-VFP) | 2 m (6.5 ft) |
| PA-4 Power Cord | 2.9 m (9.5 ft) |

## Connecting the Robot to the Power Chassis

The cable between the robot and power chassis is called the Arm Power cable. The robot end of the cable has a single large rectangular connector with a thumb-screw. The opposite end of the cable has four separate square connectors that go to the power chassis. See Figure 2-16 (the fourth connector is not used and is not shown on the drawing).

If you have an AdeptOne-MV or AdeptThree-MV start at step 1. On a Adept PackOne-MV robot the Arm Power cable is already connected with the robot (see Figure 2-18). Please start at step 2.

1. Connect the large rectangular end of the arm power cable to the Arm Power connector on the back plate of the robot. Tighten the thumb-screw securely.
2. Connect the other end of the Arm Power cable to the matching connectors on the A and B+ Amp modules in the following order.

   **NOTE:** The system integrator must add adequate strain relief for the Motor Power cable connectors at the amplifier modules.

   a. Install the plug labeled **"A" Amp #1** in the connector marked "Motor Power Output" on the A Amp at the left side of the chassis.

   b. Install the plug labeled **"A" Amp #2** in the connector marked "Motor Power Output" on the second A Amp (to the right-hand side of the first A Amp.)

   c. Install the plug labeled **"B+" Amp #1** in the connector marked "Motor Power Output" on the B+ Amp.

   d. The fourth connector on the motor power cable is used only for the Fifth Axis option, which is not available for robots with the Category 3 package.

**WARNING:** Verify that all connectors are secure and fully inserted. Failure to do this could cause unexpected robot motion.

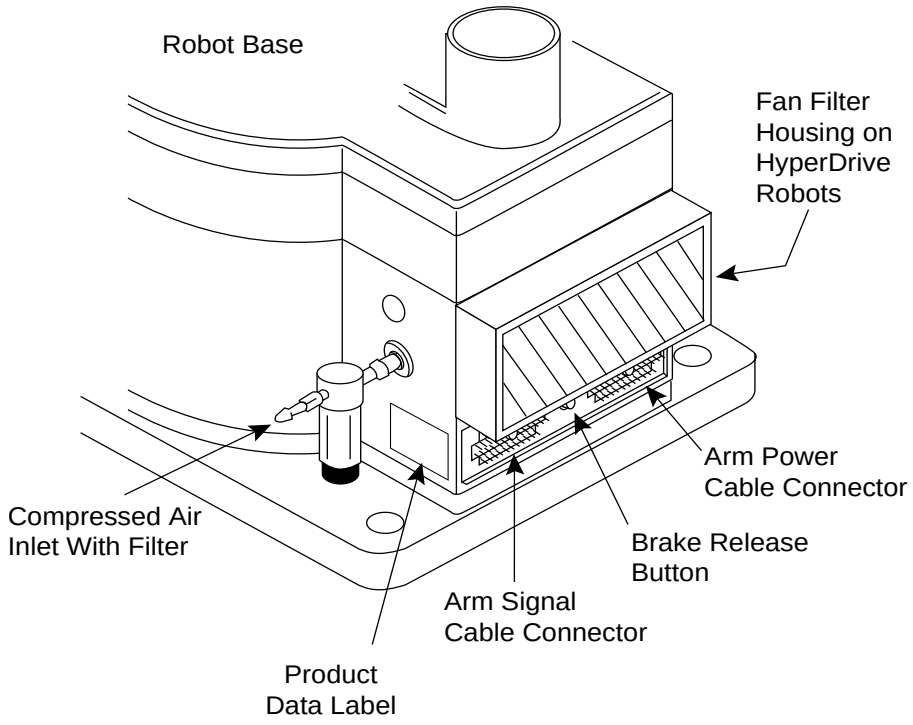



**Figure 2-17. AdeptOne-MV or AdeptThree-MV Robot Base Showing Air Filter and Cable Connector Locations**

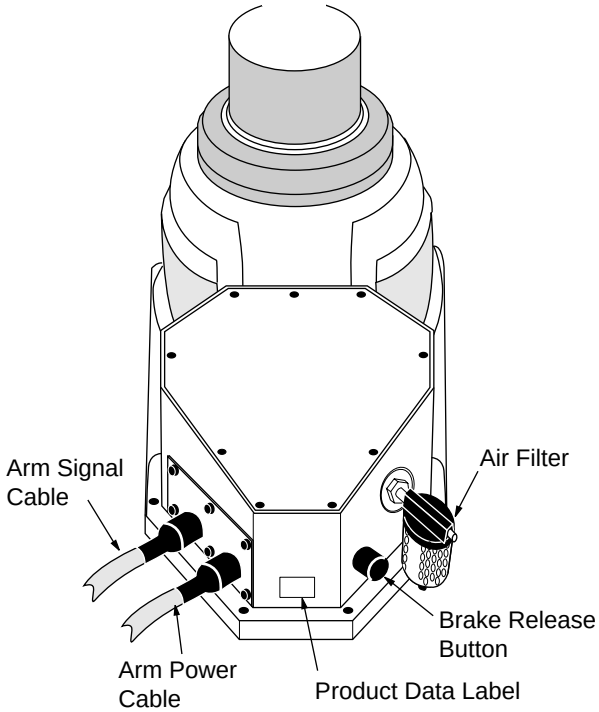



**Figure 2-18. Adept PackOne-MV Robot Base Showing Air Filter and Cable Connector Locations**

## Installing Signal Cables: Robot to MV Controller

The cable between the robot and the VJI module in the Adept MV controller is called the Arm Signal cable. The robot end has a large rectangular connector. The controller end has a 50-pin D-sub connector and two smaller 15-pin D-sub connectors. See Figure 2-16.

If you have an AdeptOne-MV or AdeptThree-MV start at step 1. On an Adept PackOne-MV robot the Arm Signal cable is already connected with the robot. Please start at step 2.

1. Connect the large rectangular end of the arm signal cable to the Arm Signal connector on the back plate of the robot. Tighten the thumb-screw securely.
2. Connect the 50-pin D-sub connector to the Arm Signal connector (lower) on the VJI module. Tighten the two captive screws securely. See Figure 2-19.
3. The 15-pin D-sub connectors are labeled User and Force. The User connector is connected to the User-to-Security Panel cable, see page 49. The Force connector is not used.

**WARNING:** Verify that all connectors are fully inserted and screwed down. Failure to do this could cause unexpected robot motion. Also, a connector could get pulled out or dislodged unexpectedly.

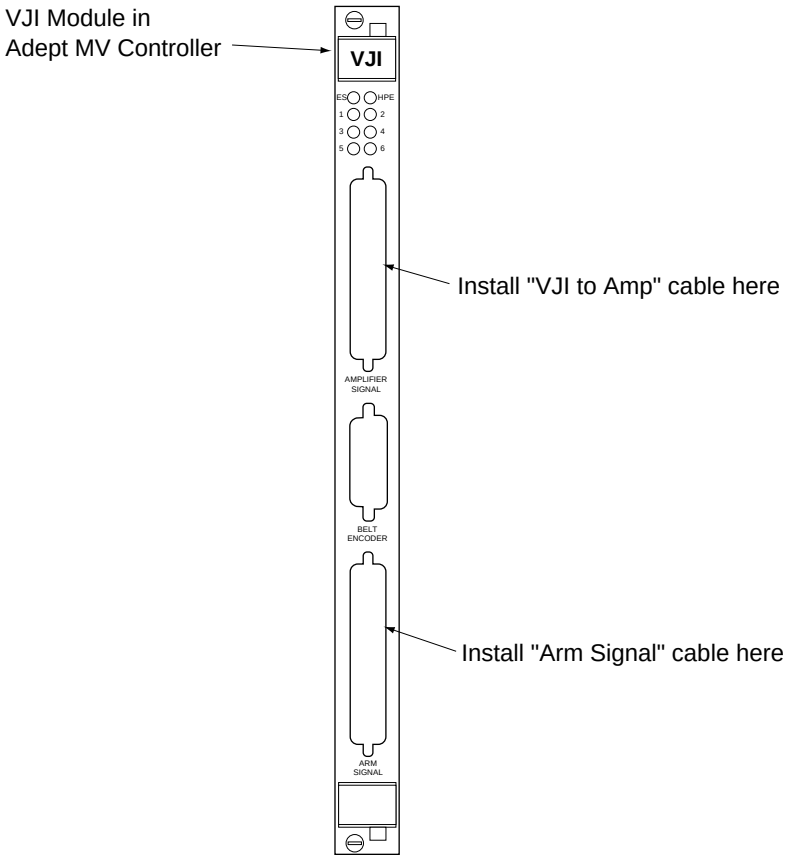



**Figure 2-19. Robot-to-VJI Cable Installation**

## Installing Signal Cables: MV Controller to Power Chassis

The VJI-to-Amp cable is the interconnect between the controller and the power chassis. This cable assembly has a single plug on one end (for the VJI) and four plugs on the other end (for the amplifiers).

1. Connect the cable end with the single connector to the connector marked Amplifier Signal (upper) on the VJI module. See Figure 2-19.
2. The other end of the cable with four plugs must be connected in the following pattern.
   a. Connect the plug labeled **Amplifier Crtl 1** to the Control Signal connector on A Amp #1. Tighten the two captive screws securely.
   b. Connect the plug labeled **Amplifier Crtl 2** to the Control Signal connector on A Amp #2. Tighten the two captive screws securely.
   c. Connect the plug labeled **Amplifier Crtl 3** to the B1 Control Signal connector on the B+ Amp. Tighten the two captive screws securely.
   d. Connect the plug labeled **Amplifier Crtl 4** to the B2 Control Signal connector on the B+ Amp. Tighten the two captive screws securely.
3. Verify that all connectors are secure and fully inserted and installed in the correct location.

**WARNING:** Verify that all connectors are fully inserted and screwed down. Failure to do this could cause unexpected robot motion. Also, a connector could get pulled out or dislodged unexpectedly.

## Connecting the MCP to the VFP

The optional MCP is connected to the system at the Pendant connector on the VFP (see Figure 2-20). See Chapter 4 for instructions on using the MCP.

Install the MCP to the connector that is marked PENDANT on the VFP.

**WARNING:** The VFP has two key switches. One to select the device that controls program execution and one to select the operating mode. Before it is possible to use the MCP in the workcell, the operating key switch must be set to MANUAL and the other one to LOCAL. This will prevent program execution from being started from the keyboard or terminal.

**CAUTION:** The coiled cable on the MCP III has been tested to withstand 500 V of repetitive electrical bursts per EN61000-4-4. Exposing the MCP to voltages higher then 500 V may cause the robot to shut down. In this event, it may be necessary to unplug, then reconnect, the MCP to restart the robot.

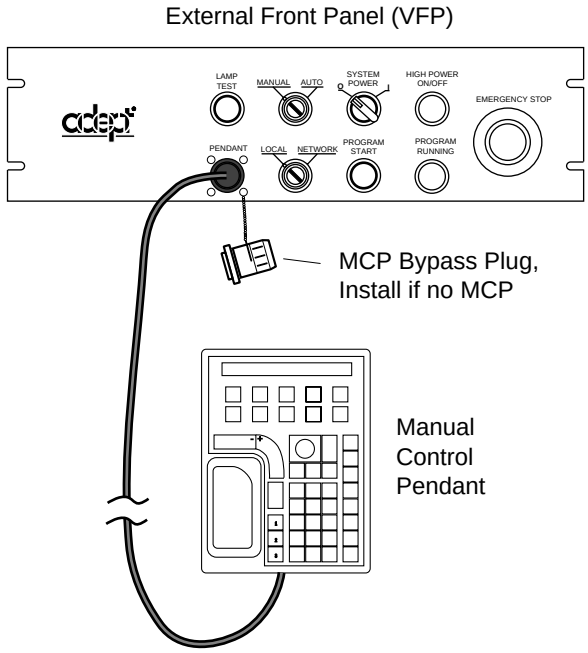



**Figure 2-20. MCP Connection**

### MCP Cradle

The MCP is stored in the MCP cradle when it is not being held by an operator. The cradle has a retaining clip that keeps the Hold-to-Run switch closed. The MCP cradle *must* be installed outside of the robot workcell. See Figure 6-13 on page 126 for the dimensions of the cradle.

## Connecting the Security Panel

The Adept Security Panel consists of two DIN-Rails, see Figure 2-21. The upper DIN-Rail (X1), called the Control Rail, contains the Category 3 Emergency Stop board and the Teach Restrict Interface board. The lower DIN-Rail (X2), called the Power Rail, contains the power supply, contactors, terminals, and circuit breaker.

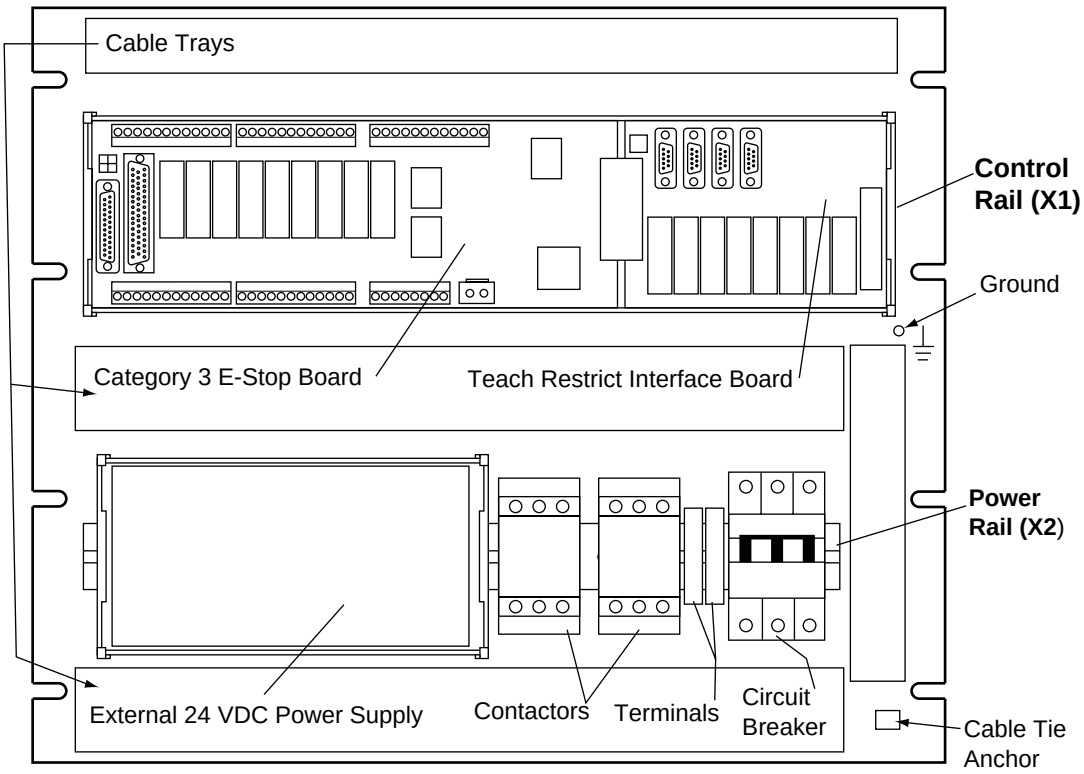



**Figure 2-21. Connectors on the Security Panel**

### Connecting the Security Panel to the SIO-Module in the Adept MV Controller

The communication between the Adept MV Controller and the Security Panel requires this connection. The SIO/DIO-to-Cat3 E-Stop cable connects the Digital I/O connector on the SIO module in the Adept MV Controller with the Category 3 Emergency Stop PCA on the Security Panel.

Installation procedure for the SIO/DIO-to-Cat3 E-Stop cable:

1. Make sure that controller On/Off switch is turned off.
2. Connect the 50-pin, D-Sub, female connector of the cable to the connector J2 on the Category 3 Emergency Stop PCA. Tighten the two captive screws securely.
3. Connect the 50-pin, D-Sub, male connector at the other end of the cable to the connector Digital I/O connector “I/O 24V 100mA “on the SIO-Module. Tighten the two captive screws securely.

### Connecting the Security Panel to the External Front Panel

Communication between the external Front Panel and the Security Panel is through the VFP-to-Cat3 E-Stop cable. The VFP has on its back side a board with a 25-pin D-Sub male connector with the label J5. On the Category 3 E-Stop board is a 25-pin D-Sub female connector with the label J3. The VFP-to-Cat3 E-Stop cable connects J5 on the VFP with J3 on the Category 3 E-Stop board.

Installation procedure for the VFP-to-Cat3 E-Stop Cable (see Figure 2-22):

1. Make sure that Adept MV controller On/Off switch is turned off.
2. Connect the male plug of the cable to the connector J3 on the Category 3 Emergency Stop board. Tighten the two captive screws securely.
3. Connect the female connector of the cable to the connector J5 on the board of the VFP. Tighten the two captive screws securely.

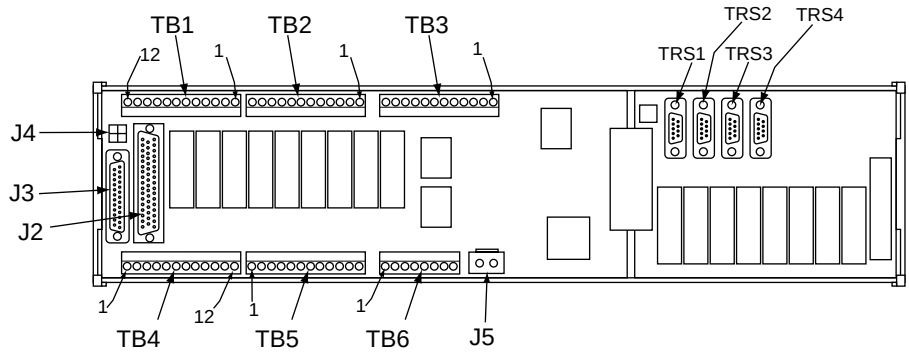



**Figure 2-22. Connectors on the Control Rail**

### Connecting the Security Panel to the Adept Robot

For speed limiting of Joint 1 and 2 in Manual mode, the User-to-E-Stop/Teach Restrict cable must be installed between the User connector on the Arm Signal cable and the Teach Restrict Interface board. The robot can not be operated in Manual mode until this connection is made. The User connector has a 15-pin, standard male D-Sub connector marked User. On the Teach Restrict Interface PCB are two connectors, a 9-pin, female D-Sub connector marked TRS1 and a rectangular 4-pin connector.

Installation procedure for the User-to-E-Stop/Teach Restrict cable (see Figure 2-16 and Figure 2-21):

1. Make sure that the power chassis and controller On/Off switches are turned off.
2. Remove the User Brake Release Jumper (if it is installed) from the User connector on the robot Arm Signal cable. Save this jumper for use with the Brake Release button, see section 4.4 on page 88.
3. Plug the 15-pin female connector, marked User at one end of the User-to-Security Panel cable to the User connector on the robot Arm Signal cable. Tighten the two captive screws securely.

   **NOTE:** The User signals normally available on the Tower assembly of non-Category 3 Adept robots are not available on Category 3 systems.

4. The other end of the cable with two plugs must be connected on the Teach Restrict Interface Board.
   a. Connect the 9-pin, D-Sub male plug, labeled TRS1 to the D-Sub connector TRS1 on the Teach Restrict Interface Board. Tighten the two captive screws securely.
   b. Connect the rectangular plug to the rectangular connector J4 on the Teach Restrict Interface Board.

**CAUTION:** Verify that all components are fully inserted and screwed down.

### Connecting the Security Panel to the Adept PA-4 Power Chassis

For speed limiting of Joint 3 and 4 in Manual Mode, the Teach Restrict-to-B+ Amp cable must be installed between the Adept PA-4 Power Chassis and the Teach Restrict Interface board on the Control Rail. The B+ Amplifier Module has a 15-pin, high-density, D-Sub female connector with the label Teach Restrict. On the Teach Restrict Interface board on the Control Rail are two 9-pin, D-Sub female connectors with the labels TRS2 and TRS3.

Installation procedure for the Teach Restrict-to-B+ Amp cable (see Figure 2-16, Figure 2-21, and Figure 2-22):

1. Make sure that the power chassis and controller On/Off switches are turned off.
2. Plug the 15-pin, high-density, D-Sub male connector at one end of the Teach Restrict-to-B Amp cable into the Teach Restrict socket on the B+ Amplifier Module in the power chassis. Tighten the two captive screws securely.
3. The other end of the cable with two plugs must be connected to the Teach Restrict Interface Board.
   a. Plug the 9-pin, D-Sub connector, labeled TRS2 into the socket TRS2 on the Teach Restrict Interface Board. Tighten the two captive screws securely.
   b. Plug the 9-pin, D-Sub connector, labeled TRS3 into the socket TRS3 on the Teach Restrict Interface Board. Tighten the two captive screws securely.

# 2.16 Grounding Information

## Adept MV Controller Grounding

The detachable three-wire power cord is used for connection to the power source and the protective ground. The protective ground conductor (colored green/yellow) in the power cord is internally connected to the exposed metal parts of the Adept MV Controller. To ensure electrical-shock protection, the protective ground conductor must be connected to a properly grounded power source.

## Adept PA-4 Power Chassis Grounding

The protective ground conductor (colored green/yellow) of the Adept PA-4 Power Chassis is internally connected to the accessible metal parts of the power chassis. To ensure electrical-shock protection, this must be connected to a properly grounded power source, via the Security Panel.

**WARNING:** Ensure that a proper protective ground connection exists before turning on the power. The Adept PA-4 power chassis and the Adept MV controller must be connected to the same earth ground.

## Security Panel Grounding

The Security Panel must be grounded using the M5 ground stud on the right side of the panel, see Figure 2-21. The ground wire should be as short as possible. Typically it would be grounded to the frame of the equipment cabinet.

## Adept Robot Grounding

The major structural parts of the robot are connected to the ground point on the base of the robot, see Figure 2-23. (See the next section for parts of the robot that are not grounded.) The user must install a ground wire at this point to ground the robot. Make sure to remove all paint from the surface under the screw at the ground point and use a star washer to ensure a proper ground connection.

At the Adept PackOne robot ground point, place the large diameter washer over the user-supplied ground lug, then tighten the bolt. Apply a silicone-based sealant to the area to protect from moisture.

## Robot-Mounted Equipment Grounding

The following parts of an AdeptOne-MV, AdeptThree-MV and Adept PackOne-MV are not grounded to protective earth: the Joint 3 quill, the tool flange, and all access covers. If hazardous voltages are present at any user-supplied robot-mounted equipment or tooling, you must install a ground connection from that equipment/tooling to the ground point on the robot base. Hazardous voltages can be considered anything in excess of 30VAC (42.4VAC peak) or 60VDC.

**WARNING:** Failing to ground robot-mounted equipment or tooling that uses hazardous voltages could lead to injury or death of a person touching the end-effector when an electrical fault condition exists.

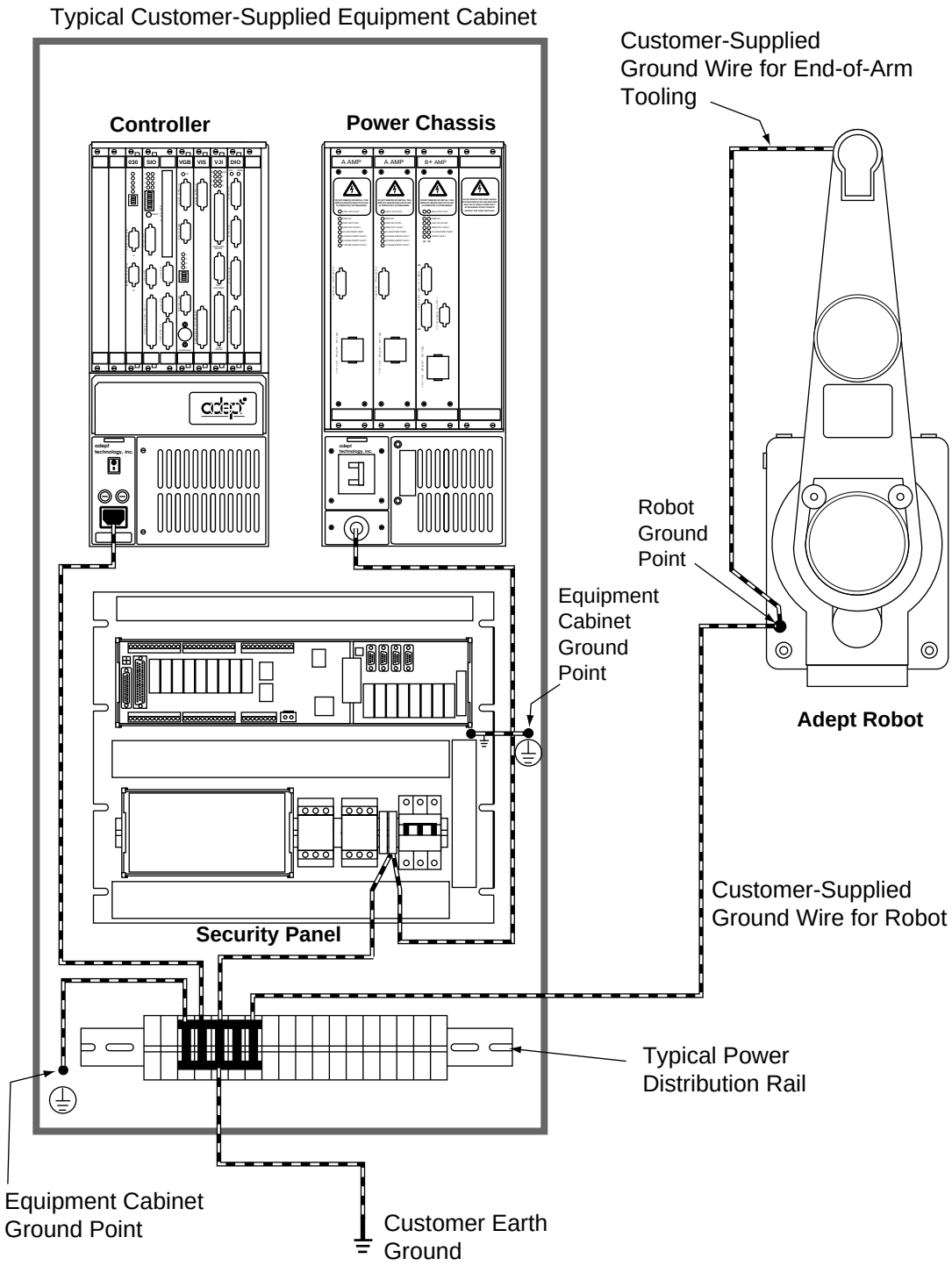



**Figure 2-23. Robot System Grounding Diagram**

# 2.17 Connecting to AC Power

AC power must be connected separately to the Adept MV controller and the Adept PA-4 power chassis, but the power should come from the same source. See Figure 2-26 and Figure 2-27. (The AC power to the power chassis is routed via the contactors on the security panel.)

## Connecting AC Power to the MV Controller

The Adept MV Controller can operate at two different voltage settings. On the identification (ID) label you will find the model and serial numbers and the voltage and current ratings. The label is located on the left side of the controller chassis. A smaller serial number label is also located on the front of the chassis above the On/Off switch. You should always have this serial number available when you call Adept Customer Service for technical support.

The Adept MV-8 and MV-19 controllers operate at either 100-120 VAC or 200-240 VAC single phase. All controllers are shipped from the factory set to 200-240 VAC single phase. Contact Adept Customer Service for details on changing to 100-120 VAC configuration.

### AC Power Requirements

**Table 2-5. Adept MV Controller Power Requirements**

| Nominal Voltage Range | Frequency/ Phasing | Minimum Operating Voltage[a] | Maximum Operating Voltage | Recommended External Circuit Breaker (user-supplied) |
|---|---|---|---|---|
| 200V to 240V (factory setting) | 50-60Hz, 1-phase | 180V | 264V | 10 amps |
| 100V to 120V | 50-60Hz, 1-phase | 90V | 132V | 10 amps |
| Power to the Adept MV controller and PA-4 power chassis must come from a single source. | | | | |

[a] The maximum interruption time (operating voltage below specification) tolerated by the controller is 16 milliseconds.

### Power Entry Module

The power entry module is located at the lower left side of the controller front panel. It contains:

- the On/Off power switch ( **I** = On, **O** = Off)
- the AC power cord socket
- the two incoming AC line fuses

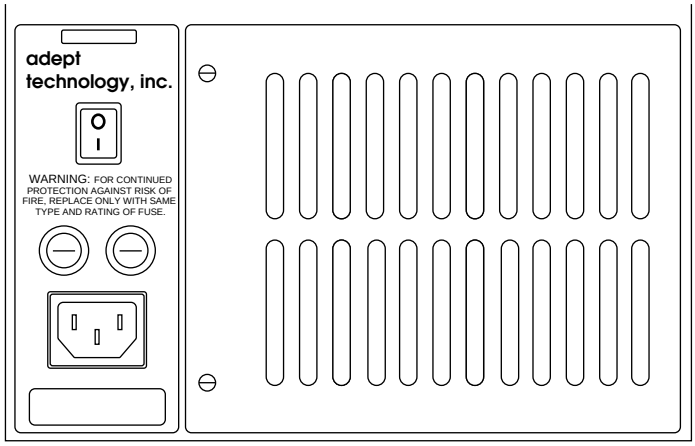

adept
technology, inc.
WARNING: FOR CONTINUED PROTECTION AGAINST RISK OF FIRE, REPLACE ONLY WITH SAME TYPE AND RATING OF FUSE.

**Figure 2-24. Adept MV Controller Power Entry Module**

### Connecting AC Power Cord

The AC power cord is included in the accessory kit. The controller end of the power cord is fitted with an IEC 320 connector. The user end of the cord is unterminated.

**WARNING:** Electrical hazard!

The installation of the power cord must be done by a skilled person. The power supply can injure or kill the person who installs the cord or an incorrect installation can injure or kill anybody who touches the equipment in the robot workcell.

Connect each conductor of the power cord securely to your AC power source, using the color code below. You must provide a suitable plug or other facility connection in accordance with all applicable European and national codes. See the section 2.16 on page 51 for important information on system grounding.

**Table 2-6. Adept MV Controller Power Cord Specifications**

| | |
|---|---|
| Cord length | 3 meters ±0.1 m (9 ft. 10 in. ±4 in.) |
| Cord rating | 10 amps |
| Number and size of conductors | 3 x 1.00 $mm^2$ |
| Color code | |
| line | brown |
| neutral | blue |
| ground | green/yellow |

## Connecting AC Power to the Adept PA-4 Power Chassis (through the Security Panel)

The Adept PA-4 power chassis provides amplified power signals to drive the robot motors in an Adept robot system. The amplifier modules in the Adept PA-4 power chassis receive control signals from the Adept MV controller. The amplifier modules then provide the necessary current to drive the various robot joint motors.

The Adept PA-4 power chassis is shipped from the factory configured for either 380-415 VAC or 200-240 VAC operation, depending on your sales order. A voltage setting label is located on the front of the chassis below the circuit breaker. The voltage setting is also shown on the ID label on the side of the chassis. Verify that the setting matches your facility power before installation. This chassis is designed for 3-phase operation only.

If you need to change the AC voltage setting from 380-415 VAC to 200-240 VAC, see page 60.

**WARNING:** Electrical hazard!
Verify the voltage settings are correct before turning on power. Operating the Adept PA-4 power chassis with incorrect voltage settings can cause damage or injury.

### AC Power Requirements for Power Chassis

**Table 2-7. Adept PA-4 Power Chassis Power Requirements[a]**

| Nominal Voltage Range | Frequency/ Phasing | Minimum Operating Voltage | Maximum Operating Voltage | Recommended External Circuit Breaker (user-supplied) |
|---|---|---|---|---|
| 380 to 415 VAC | 50-60Hz, 3-phase with neutral | 342 VAC | 424 VAC | 20 amps |
| 200 to 240 VAC | 50-60Hz, 3-phase | 180 VAC | 245 VAC | 20 amps |
| Power to the Adept MV controller and PA-4 power chassis must come from a single source. | | | | |

[a] Specifications for the Power Chassis are based on an Adept PA-4 with two A and one B+ amplifier modules and an AdeptOne-MV, an Adept PackOne-MV, or an AdeptThree-MV robot.

### Connecting the Power Cord of the Power Chassis to the Security Panel

The 3-phase AC power cord of the PA-4 power chassis must be installed at the contacts on the Power Rail (X2). See Figure 2-25.

**WARNING:** Electrical hazard!
The installation of the power cord must be done by a skilled person. The power supply can injure or kill the person who installs the cord or an incorrect installation can injure or kill anybody who touches the equipment in the robot workcell.

The user end of the cord is unterminated. Connect each conductor of the power cord securely to the contacts of the contactor AP2 and terminals for protective ground and the neutral. Use Table 2-8 for the information about the terminal numbers and the color code for the connections. The installation must meet all applicable European, international and national standards and regulations.

**Table 2-8. Connecting Power Cord of the Power Chassis to the Terminals on the Power Rail (X2)**

| Wire/Description | Wire Color | Terminal Number |
|---|---|---|
| Color code: 3Ø, 380 - 415VAC | | |
| line 1 | black | X2:AP2.T1 |
| line 2 | black | X2:AP2.T2 |
| line 3 | brown | X2:AP2.T3 |
| neutral | blue | X2:N |
| ground | green/yellow | X2:PE |
| Color code: 3Ø, 200 - 240VAC | | |
| line 1 | black | X2:AP2.T1 |
| line 2 | black | X2:AP2.T2 |
| line 3 | brown | X2:AP2.T3 |
| **no connection** | **blue** (must be insulated, see page 60) | - |
| ground | green/yellow | X2:PE |

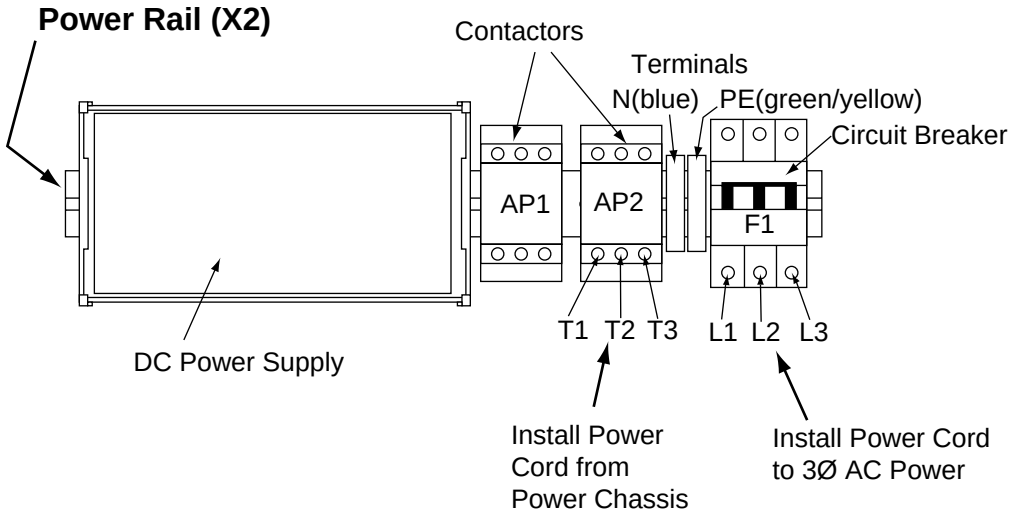



**Figure 2-25. Connectors on Power Rail**

### Connecting AC Power to the Security Panel

The main AC power supply for the robot is connected to the circuit breaker F1 on the Power Rail (X2). The 3-phase AC power cord must be supplied by the user. The current rating should equal or exceed that in Table 2-9. The cord must meet all applicable European, and national standards and regulations for current/voltage ratings, wire gauge, colors, etc.

Connect each conductor of the power cord securely to your AC power source, using the first two columns of Table 2-10 for the color code. Install the other end of the power cord to the terminals shown in the Terminal Number column. The installation must meet all applicable European and national standards and regulations.

**WARNING:** Electrical hazard!

The installation of the power cord must be done by a skilled person. The power supply can injure or kill the person who installs the cord or an incorrect installation can injure or kill anybody that touches the equipment in the robot workcell.

**Table 2-9. Customer-Supplied AC Power Cord Specifications, for Security Panel**

| | |
|---|---|
| Cord rating | 25 amps |
| Number and size of conductors | 380 - 415 VAC = 5 x 2.5 $mm^2$<br>200 - 240 VAC = 4 x 2.5 $mm^2$ |

**Table 2-10. Connection of Main AC Power Cord to the Circuit Breaker on the Power Rail (X2)**

| Wire/Description | Wire Color | Terminal Number |
|---|---|---|
| Color code: 3Ø, 380 - 415VAC | | |
| line 1 | black | X2:F1.L1 |
| line 2 | black | X2:F1.L2 |
| line 3 | brown | X2:F1.L3 |
| neutral | blue | X2.N |
| ground | green/yellow | X2.PE |
| Color code: 3Ø, 200 - 240VAC | | |
| line 1 | black | X2:F1.L1 |
| line 2 | black | X2:F1.L2 |
| line 3 | brown | X2:F1.L3 |
| ground | green/yellow | X2.PE |

### Typical AC Power Installation Diagrams

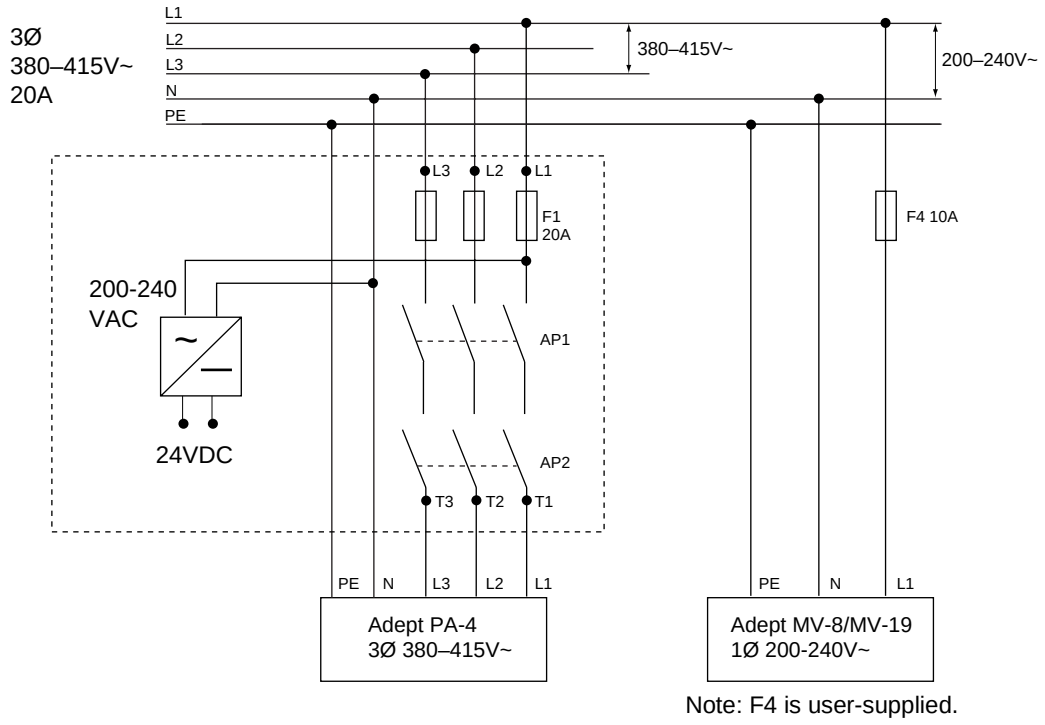



**Figure 2-26. Typical 380-415 V AC Connection for Category 3 System**

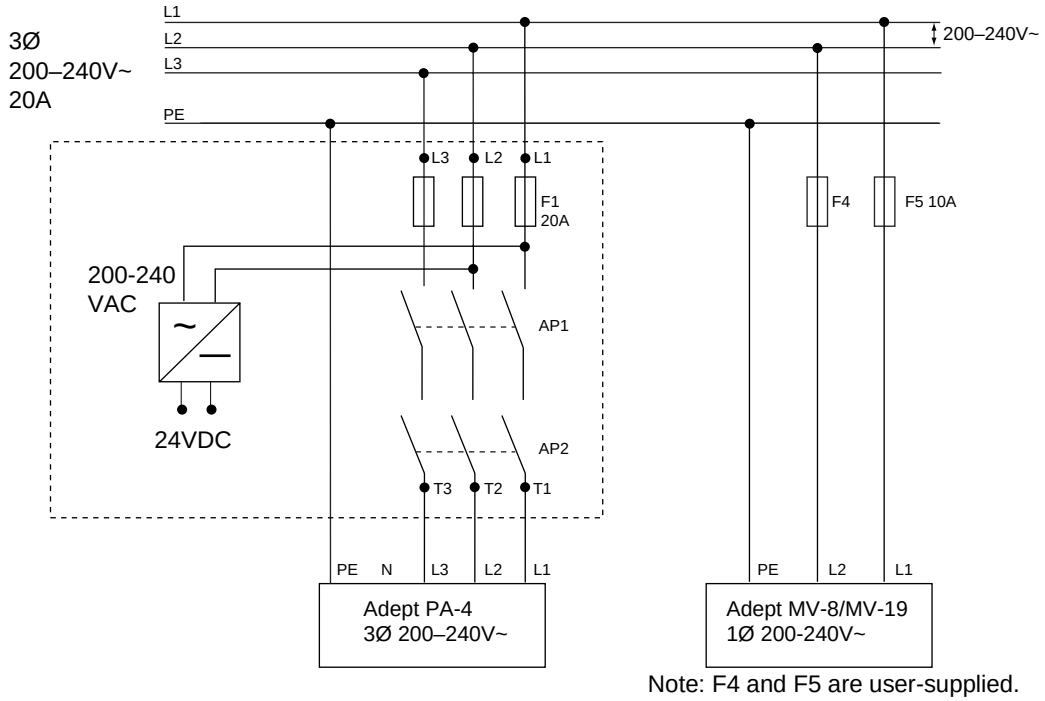



**Figure 2-27. Typical 3-Phase 200-240 V AC Connection for Category 3 System**

### Changing Voltage Setting for Power Chassis

If you need to change the AC voltage setting from 3-phase 380-415 VAC to 3-phase 200-240 VAC, you must follow the three-part procedure below. This procedure must be done only by a skilled person and should be performed before installing the power chassis.

**WARNING:** Electrical hazard!
Changing the voltage setting in the power chassis must be done by a skilled person. The power supply can injure or kill a person who does not perform this procedure correctly.

**Part 1 – Insulating Power Chassis Power Cord**

**WARNING:** High AC voltage is coupled through EMI capacitors to the blue wire of the PA-4 power chassis power cord. If you change the voltage setting from 380-415 VAC to 200-240 VAC, you must insulate the blue wire according to the directions provided below.

1. Make sure the power chassis and controller are turned off. Disconnect the controller and the Security Panel from the AC power source. Verify that power remains off during all three parts of this procedure.
2. Disconnect the 5-wire power chassis power cord from the AP2.T1,T2,T3, Neutral, and Protective Earth terminals on the Security Panel.
3. Locate the two pieces of shrink tubing in the accessory kit; one is 7 mm (1/4 inch) diameter, the other is 19 mm (3/4 inch).
4. Place the 7 mm shrink tubing over the end of the blue wire in the power cord and use a heat gun to apply it. See Figure 2-28.
5. Fold the blue wire back and place the 19 mm shrink tubing over the end of the power cord. Use a heat gun to apply the shrink tubing.
6. Re-install the power chassis power cord at the Security Panel according to the 200-240 VAC section in Table 2-8. See also Figure 2-27.

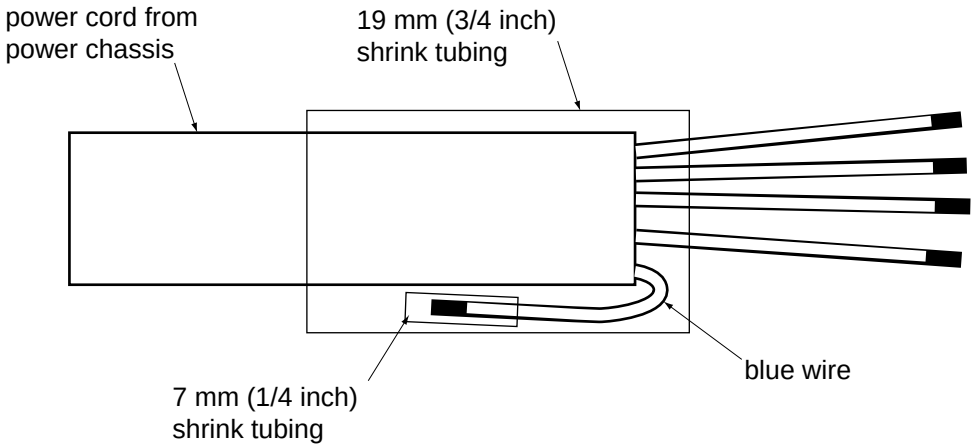



**Figure 2-28. Insulating Blue Wire in Power Cord**

**Part 2 – Moving Blue Wire on Security Panel**

7. Locate the blue wire labeled **Neutral** that is installed on the neutral terminal on the Power Rail (X2:N).
8. Remove that wire from the neutral terminal and install it in the L2 position on contactor AP1 (X2:AP1.L2), next to the wire that is already installed there.

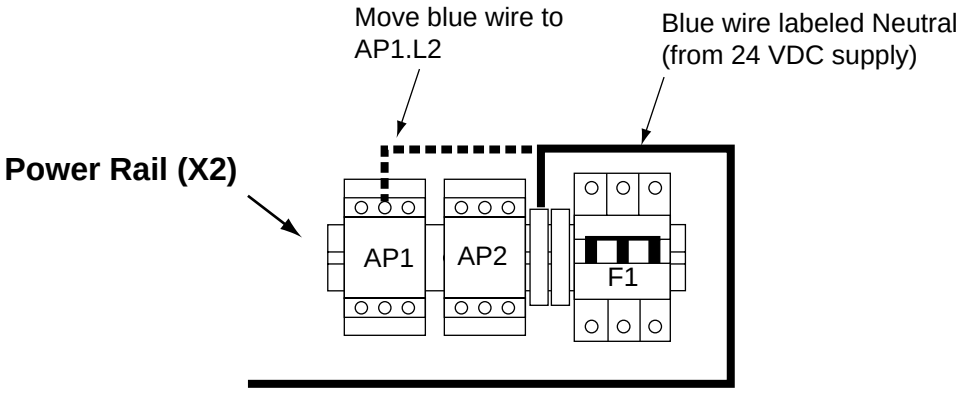



**Figure 2-29. Moving Blue Wire From Neutral to AP1.L2**

**Part 3 – Rotating Voltage Selector in Power Chassis**

9. Open the front air-intake grill on the power chassis by loosening two screws and swinging the grill out.
10. Inspect the voltage setting; it is marked on the front of the voltage selector plug. To change the voltage setting, remove the selector, rotate it 180° so the required setting is shown, and replace it. See Figure 2-30.
11. Close the grill and secure the two screws.
12. Clearly mark or alter the ID label (on the side of the chassis) to show the new voltage configuration.
13. Clearly mark or paste an alternative label over the existing label below the circuit breaker (on the front of the chassis) to show the new voltage configuration.
14. Re-connect the controller and Security Panel to the AC power source.

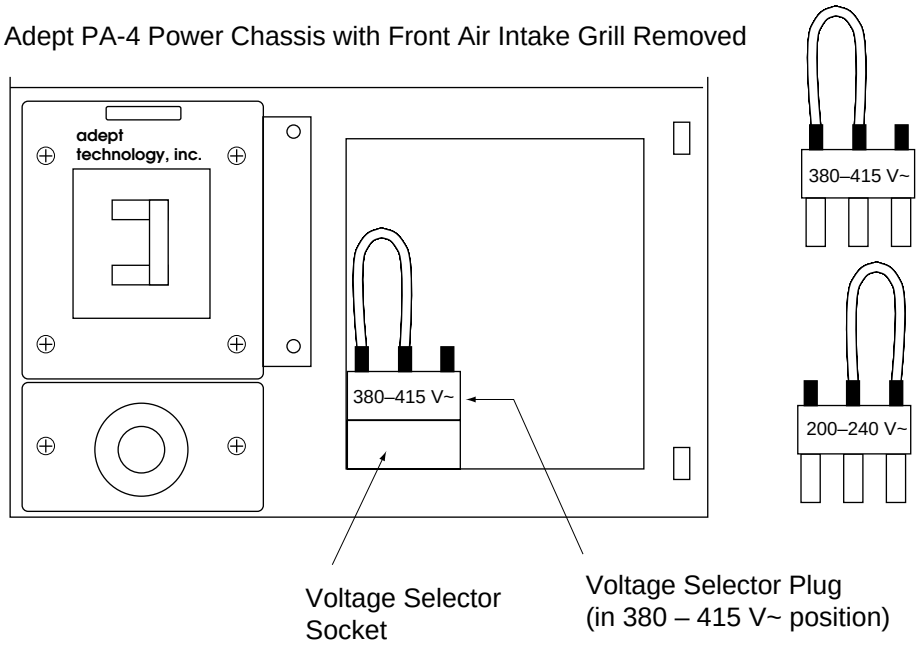


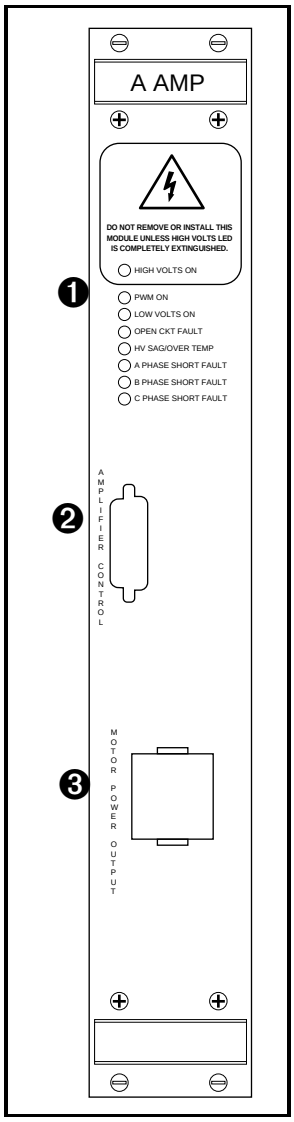

**Figure 2-30. Changing Voltage in Power Chassis**

# 2.18 Additional Power Chassis Information

## A Amplifier Module Overview

The A Amplifier module is a plug-in module that contains the circuitry and amplifying components to drive the Joint-1 or Joint-2 motor in an AdeptOne-MV or an Adept-Three-MV robot. In a typical robot system, there are two A Amplifier modules in the Adept PA-4 power chassis. The A Amp module on the left-hand side, called Amp #1, drives the motor for Joint 1. The A Amp module to the right-hand side, called Amp #2, drives the motor for Joint 2.

### Connectors and Indicators




❶ Status LED's. When an LED is turned on it indicates the following conditions:

**High Volts On** indicates the high voltage to the amps is turned on.

**PWM On** indicates that current servo is on. It does not go on until calibration is complete.

**Low Volts On** indicates the low voltage supply in the power chassis is on.

**Open Ckt Fault** indicates that an open circuit in the motor leads has been detected.

**HV Sag/Over Temp** indicates that the input voltage has dropped below the specified level or an over-temperature fault has been detected on an amp module.

**Phase A, B, C Short Fault** indicate that an over-current in the motor leads to one of the phases has been detected.

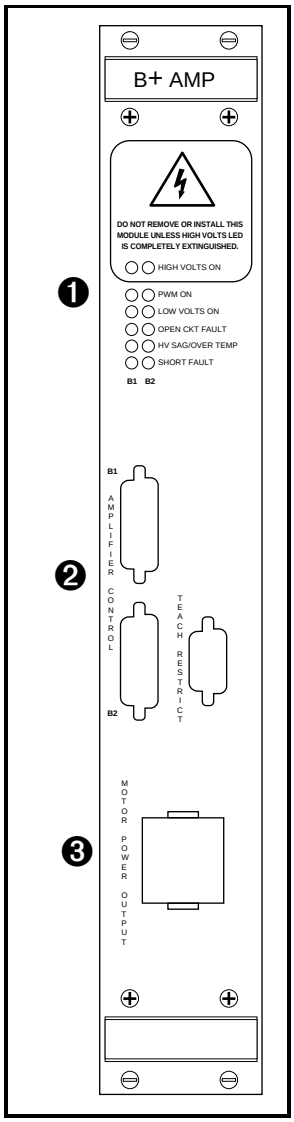
❷ **Amplifier Control** connector – the VJI-to-Amp cable connector is installed here.

❸ **Motor Power Output** connector – the Arm Power cable is installed here.

## B+ Amplifier Module Overview

The B+ Amplifier module is a plug-in module that contains the circuitry and amplifying components to drive two robot motors. In a typical Adept robot system, there is one B+ Amplifier module in the Adept PA-4 power chassis. This Amp module, located to the right of the A Amp modules, drives the motors for Joints 3 and 4.

### Connectors and Indicators




❶ Status LEDs. The left-hand column of LEDs is for the first motor controlled by this module; the right-hand column is for the second motor controlled by this module. When an LED is turned on it indicates the following conditions:

**High Volts On** indicates the high voltage to the amps is turned on.

**PWM On** indicates that current servo is on. It does not go on until calibration is complete.

**Low Volts On** indicates the low voltage supply in the power chassis is on.

Note: the three LED pairs below indicate faults and are visible momentarily before the system turns off.

**Open Ckt Fault** indicates that an open circuit in the motor leads has been detected.

**HV Sag/Over Temp** indicates that either the input voltage has dropped below the specified level or an over-temperature fault has been detected on an amp module.[1]

**Short Fault** indicates that an over-current in the motor leads has been detected.

❷ **Amplifier Control** connector – the VJI-to-Amp cable connectors are installed here.
**Teach Restrict** connector – the Teach Restrict-to-B+ Amp cable is installed here.

❸ **Motor Power Output** connector – the Arm Power cable is installed here.

[1] On B+ amplifier modules at revision level P2 or greater, or revision A or greater, the left-hand LED when lit indicates that the fault was caused by a sag in voltage. The right-hand LED when lit indicates the fault was caused by an over-temperature condition on the amplifier heat sink.

## Power Chassis Circuit Breaker and Fuse Information

**NOTE:** The SSER, LVON, HPON, and ILMT labels on the lower right corner of the front of the power chassis are for diagnostic LEDs that can be viewed behind the front grill. These LEDs are for Adept Field Service use only.

### Chassis Circuit Breaker

The power chassis circuit breaker is rated at 15A, and is located on the lower-left front of the chassis, on the power entry module. It also functions as an on/off switch to isolate the chassis.

**CAUTION:** If the circuit breaker trips due to current overload, it indicates an internal fault. Do not reset the circuit breaker yourself, contact Adept Customer Service at the numbers listed in Chapter 1.

### Chassis and Amplifier Module Fuses

Six chassis fuses are located inside the base of the power chassis on the power control board. These fuses are not user-replaceable. If you suspect that a chassis fuse may have blown, contact Customer Service.

In addition to the fuses in the power chassis, there are additional fuses located inside the power amplifier modules. The amplifier fuses are not user-replaceable. If you suspect that an amplifier fuse may have blown, contact Customer Service.

**CAUTION:** Failure of a chassis or an amplifier fuse indicates an internal circuit fault which must be corrected before the fuse is replaced. Do not attempt to replace the fuse yourself, contact Adept Customer Service at the numbers listed in Chapter 1.

## Removing and Installing Amplifier Modules

The Adept PA-4 power chassis is shipped from the factory with the amplifier modules installed in the chassis. Any unused slots are filled with blank covers. Normally you will not need to remove the amplifier modules. If you do need to remove and re-install a module for some reason, follow the instructions below. The four slots in the chassis are not interchangeable, some slots have special control signals. The amplifier modules are factory-installed in the correct slots. Contact Adept Customer Service if you need to relocate any modules.

**WARNING:** Do not attempt to install or remove any amplifier modules without first turning off the power to the power chassis and all related external power supplies. Failure to observe this warning could cause injury or damage to your equipment.

### Removing Amplifier Modules

1. Turn off the power chassis and the Adept MV controller.
2. Note the location of any cables connected to the module, then disconnect them.
3. Loosen the captive screws at the top and bottom of the module.

4. Using both the top handle and bottom handle, pull the module straight out of the chassis. Remove the module from the chassis and store it in a safe place.

**CAUTION:** You must take precautions to prevent amplifier modules from being exposed to electro-static discharge (ESD) while you are handling or storing them. Adept recommends using an anti-static ground strap on your wrist when handling modules.

### Installing Amplifier Modules

1. Turn off the power chassis and the Adept MV controller.
2. If the slot has a blank panel installed, loosen the captive screws at the top and bottom of the panel and remove it.
3. Verify that the intended slot for the module is ready to accept the module.
4. Align the module with the card guide slots at the top and bottom of the card cage. Slide the module in slowly. Apply straight-forward pressure to the top and bottom handles until it is firmly seated in the rear power connector, and the face of the module is flush with the other modules.

   It should not be necessary to use excess pressure or force to engage the connector. If the board does not properly connect with the rear power connector, remove the module and inspect the connector and guide slots for possible damage or obstructions.
5. Tighten the captive screws at the top and bottom of the module.

**WARNING:** There is an interlock circuit that prevents enabling power if the amp module screws are not tightened securely. This also applies to any blank panel cover(s). There are dangerous voltages present inside the power chassis, do not attempt to operate without blank panel cover(s) installed in any unused slots.

## 2.19 Connecting Compressed Air Supply to the Robot

The user must supply all tubing and fittings to plumb the facility air supply to the robot. The robot is supplied with an air filter with a standard 1/4-inch Industrial Interchange nipple. The compressed air to the robot must meet the specifications listed in section 2.1 on page 19.

For the Adept PackOne-MV robot you must supply a desiccant or refrigerated compressed air dryer.

**CAUTION:** The compressed air supply to the **Adept PackOne-MV Robot** must be turned on 24 hours per day to provide constant protection from internal condensation. Failure to supply air to the robot 24 hours per day can void the warranty.

# 2.20 Installing End-Effectors on an AdeptOne-MV/AdeptThree-MV Robot

Providing an end-effector or other end-of-arm tooling is the responsibility of the User. An end-effector can be attached to the flange by using a ring clamp (supplied) or four 8-32 screws (supplied). If hazardous voltages are present at the end-effector, you should install a ground connection from the base of the robot to the end-effector. See section 2.16 on page 51. Also see Chapter 6 for dimensions of the User flange.

## Clamp-mounted End-Effector

The following procedure describes the installation of a typical end-effector using the ring clamp. (Refer to Figure 2-31.)

1. Disconnect the air supply to the robot.
2. Remove the plugs from the Open and Close air lines where they protrude from the quill flange.
3. Place the ring clamp over the quill flange.
4. Install the Open and Close air lines onto the appropriate fittings on the end-effector.
5. Test the operation of the end-effector to ensure that the Open and Close functions are not reversed.
6. Mate the end-effector flange to the quill flange. Rotate the end-effector until its key aligns with the keyway in the quill flange, then place the ring clamp over both flanges and tighten the clamp screw.

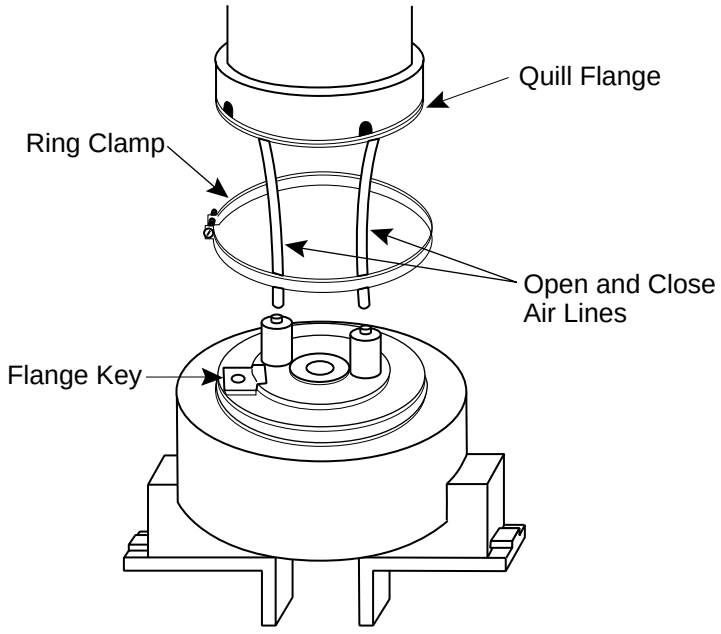



**Figure 2-31. Clamp-mounted End-Effector Installation**

## Screw-mounted End-Effector on AdeptOne-MV and AdeptThree-MV Robots

The following procedure describes installing an end-effector using four screws. (See Figure 2-32.)

1. Disconnect the air supply to the robot.
2. Remove the plugs from the Open and Close air lines where they protrude from the quill flange.
3. Install the Open and Close air lines onto the appropriate fittings on the end-effector.
4. Mate the end-effector flange to the quill flange. Rotate the end-effector until its key aligns with the keyway in the quill flange.
5. Test the operation of the end-effector to ensure that the Open and Close functions are not reversed.
6. Insert four 8-32 screws through the mounting holes and tighten. Recommended torque is 1.69 Nm (15 in-lb). If the screws protrude slightly through the flange, align the cutouts in the Joint 3 hardstop (located just above the quill flange) to accommodate the screw tips.

**CAUTION:** Do not allow the mounting screws to protrude up into the hardstop any farther than the cutouts, because this can prevent proper seating of the flange against the hardstop. Improper seating against the hardstop will prevent the robot from calibrating properly and will cause all of the previously taught robot locations to have the wrong height.

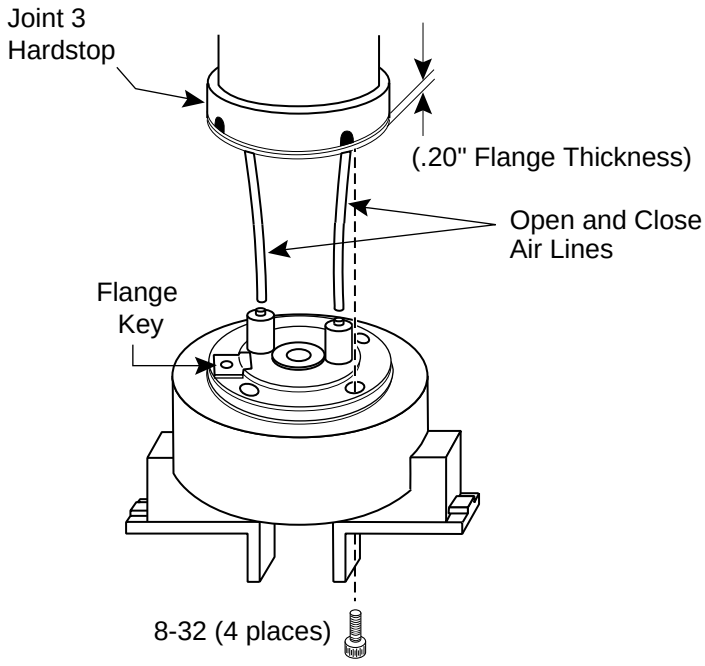



**Figure 2-32. Screw-mounted End-Effector Installation**

## 2.21 Installing End Effectors on an Adept PackOne-MV Robot

Provision of an end effector or other end-of-arm tooling is the responsibility of the User. Also, USDA or other regulatory agency acceptance of end effectors is the responsibility of the User. If hazardous voltages are present at the end-effector, you should install a ground connection from the base of the robot to the end-effector. See section 2.16 on page 51. Also see Chapter 6 for dimensions of the User flange.

### Installation

An end effector can be attached to the flange by using a ring clamp (supplied) or a gasket and four 8-32 screws (supplied). The gasket attachment method is more hygienic but not as convenient as the ring clamp. For details of the flange mounting surface and alignment pin specifications ask the Adept Customer Service.

#### Clamp-mounted End Effector

The following procedure describes the installation of a typical end effector using the ring clamp. (Refer to Figure 2-33.)

1. Disconnect the air supply to the robot.
2. Remove the plugs from the Open and Close air lines where they protrude from the user flange.
3. Place the ring clamp over the user flange.
4. Install the Open and Close air lines onto the appropriate fittings on the end effector.
5. Mate the end-effector flange to the user flange. Rotate the end effector until its alignment pin lines up with the alignment pin hole in the user flange, then place the ring clamp over both flanges and tighten the clamp screw.
6. Reconnect the compressed air supply.

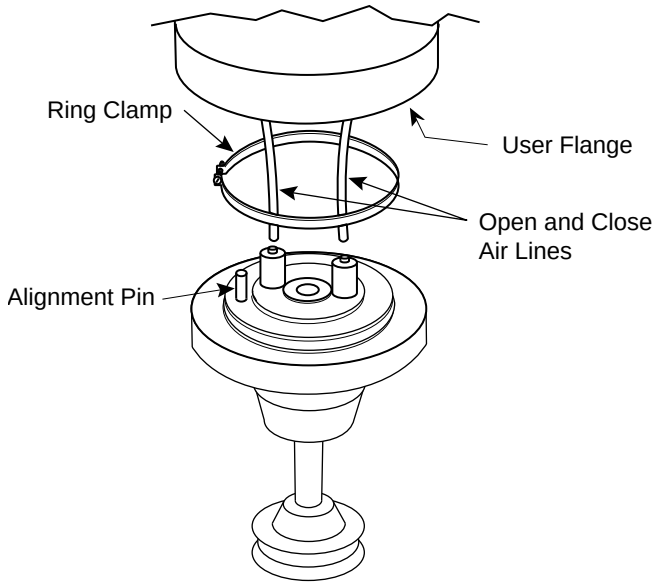



**Figure 2-33. Clamp-mounted End Effector Installation for Adept PackOne-MV Robot**

### Screw-mounted End Effector

The following procedure describes installing an end effector using four screws. (See Figure 2-34.)

1. Disconnect the air supply to the robot.
2. Remove the plugs from the Open and Close air lines where they protrude from the user flange.
3. Install the Open and Close air lines onto the appropriate fittings on the end effector.
4. An adhesive-backed gasket is supplied with the robot to provide a hygienic seal between the user flange and end effector. This gasket can be applied to either the user flange or the end effector flange.

   Mate the end-effector flange to the user flange. Rotate the end effector until its alignment pin lines up with the alignment pin hole in the user flange.
5. Insert four 8-32 screws through the mounting holes and tighten. Recommended torque is 1.7 Nm (15 in-lb).
6. Reconnect the compressed air supply.

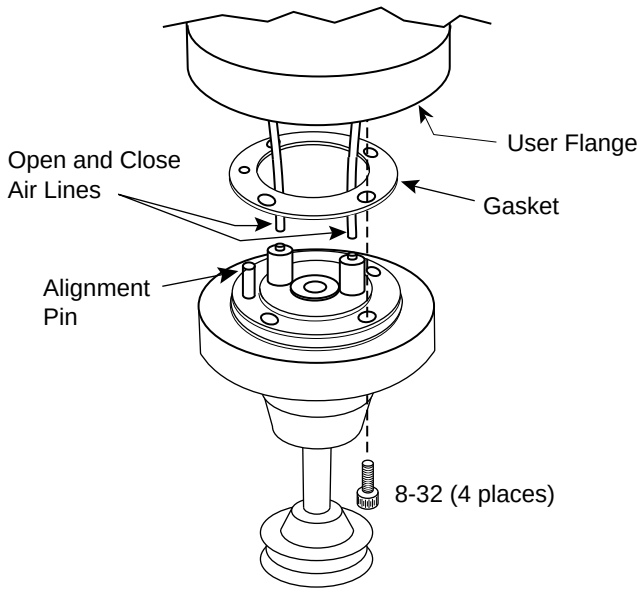



**Figure 2-34. Screw-mounted End Effector Installation for Adept PackOne-MV Robot**

# Preparation for Safe and Effective Use of the Robot 3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## 3.1 Overview of Safety System

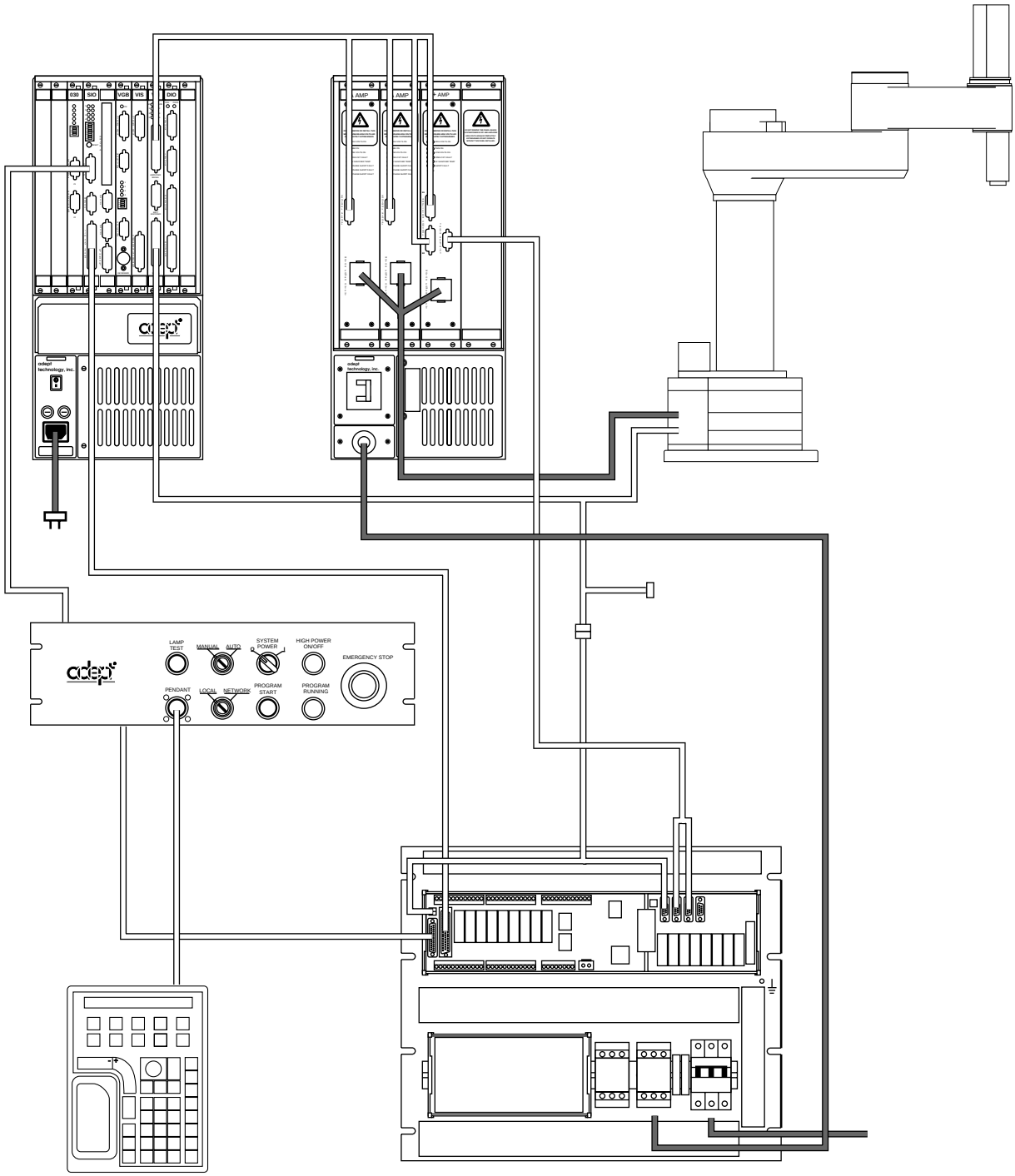


**Figure 3-1. Components of a Category 3 E-Stop System**

## Introduction

The Emergency Stop system on this type of Adept robot has several components, see Figure 3-1. The most important component is the Security Panel, because it controls the Category 3 E-Stop system. It works together with the AUTO/MANUAL operating mode keyswitch on the external Front Panel. It is important to understand the interconnections between the Security Panel and the other Adept parts.

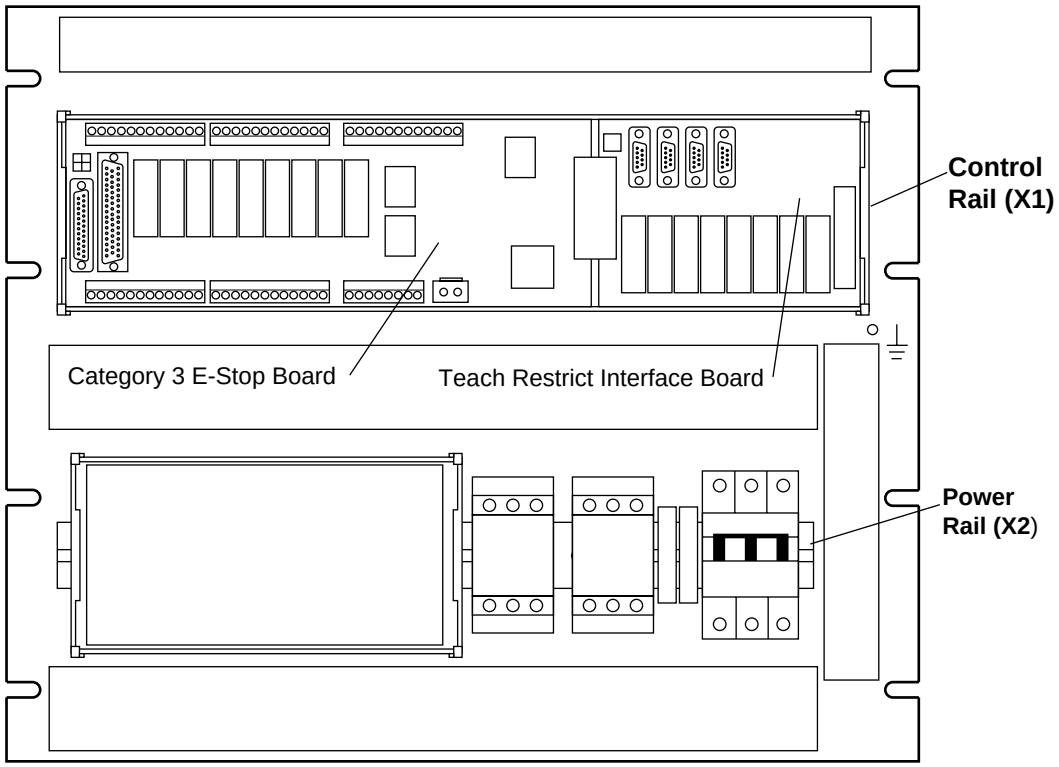


**Figure 3-2. Security Panel**

Figure 3-2 shows the Security Panel with all its components. On the left side of the Control Rail (upper one) is the Category 3 E-Stop board with the terminals for the connections of customer-supplied safety equipment and digital I/O signals. On the right side is the Teach Restrict Interface Board. The lower DIN rail is the Power Rail (X2) containing the external 24 VDC power supply, the contactors, and the circuit breaker for the power chassis.

## Security Panel Functions

It is the function of the Security Panel to:

- check for faults in the safety systems prior to power-up in Manual mode (cyclic checking)
- remove power from the robot if the Teach Restrict sensors in the robot and power chassis detect excessive speed and/or acceleration while the robot is in Manual mode

- interlock with Category B safety circuitry in the Adept MV controller[1]
- indicate to the Adept MV controller the source of emergency stop conditions.

The Emergency Stop circuitry has two independent channels and is so constructed that no single failure can cause a loss of the safety function and that any latent failures can be detected before power is applied – the definition of Category 3 operation.

As shown in Appendix A, redundant connections are provided on the Security Panel for customer Emergency Stop safety barriers. If one of these switches or contacts is open, High Power will be turned off. The Security Panel also supplies voltage-free contacts that are closed when High Power is on and open when High Power is off. These contacts can be used to switch on and off additional equipment depending on the status of the E-Stop circuit.

The Security Panel also supplies voltage-free contacts to signal that the robot is in Manual mode. These contacts can be used by the customer to disconnect input devices or other external peripherals (turn-tables, conveyors, etc.)

### Description of Mute Capability

There are two pairs of terminals (see Table 3-1) on the Security Panel for customer safety barriers that can be muted in Manual mode. Input to these terminals from a safety barrier is muted (not active) in Manual mode, but the input *is* active in Automatic mode. That means that an interlock switch on a workcell access door can be connected to these terminals, and the door can be left open in Manual mode. This is useful for a person who is teaching points in the workcell during program development.

There is a second pair of terminals for a second barrier. This pair of inputs is always active, even in Manual mode. This feature can be used for an inner barrier, safety mat, or light curtain.

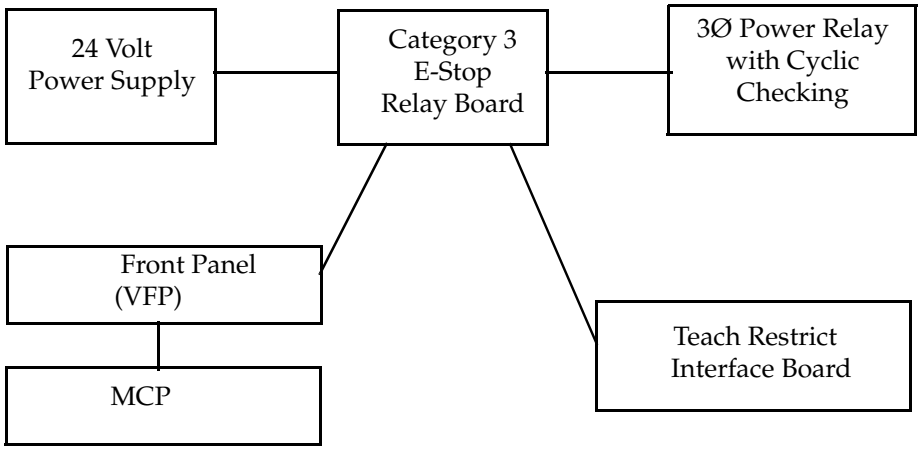


**Figure 3-3. Main Components of the Safety System**

[1] Per EN954, Category B refers to a component that meets the requirements of its environment (voltage, current, temperature). Such components are not necessarily fault tolerant.

### Operating in Manual Mode

The most important function of the Security Panel is to protect the operator in Manual mode. To work in Manual mode, the operator switches the lower key switch on the VFP to the LOCAL position and the operating mode key switch (upper switch) to the MANUAL position. Then the operator gives the instruction to enable High Power, either through the ENABLE POWER software instruction, or pressing the COMP/PWR button on the MCP. The system starts the process to enable High Power. The sequence to enable High Power in Manual mode is as follows (takes about 20-25 seconds):

- system check of all E-stops (including Customer non-mute safety barrier)
- operator interactive test of MCP Hold-to-Run switch
- automatic test of Teach Restrict sensors in robot and power chassis (cyclic checking)
- the VFP HIGH POWER ON/OFF push button starts blinking*
- operator presses the VFP HIGH POWER ON/OFF button
- contactors close on Security Panel, and power chassis amplifiers supply High Power to robot motors

*The system waits until the HIGH POWER ON/OFF push button is pressed. If the button has not been pressed in a selected time, the system stops enabling power with an error message.

While in Manual mode, the robot speed is limited to 250 mm per second (10 ips). The motors also run at reduced torque. This is to protect a person who is in the workcell teaching points with the MCP during program development. It is important to remember that the robot speed is *not* limited when the robot is in Automatic mode.

## 3.2 Category 3 Emergency Stop and Teach Restrict Equipment

The Category 3 Emergency Stop and Teach Restrict Equipment is located on the Control Rail on the Security Panel. For the installation of Adept-supplied equipment to the Security Panel see Chapter 2. Figure 3-4 shows the Category 3 E-Stop board (left side) and the Teach Restrict board (right side).

**NOTE:** Removable terminal block connectors for TB1 to TB5 on the Category 3 Emergency Stop board are supplied in the accessory kit. Use these connectors to install customer wiring. Adept recommends using crimp-on ferrules on all wires that are installed into terminal blocks.

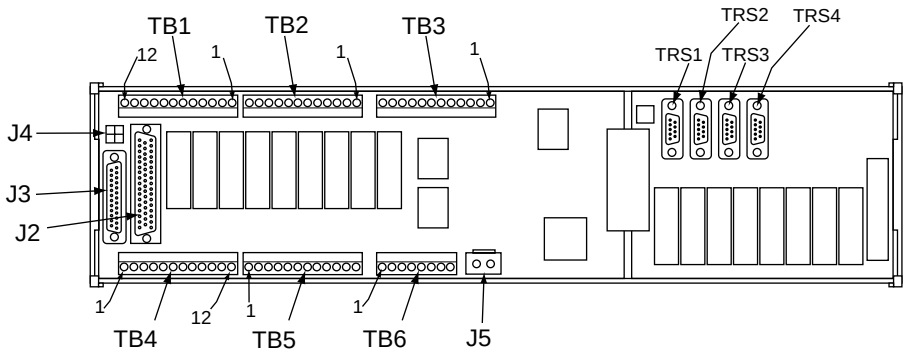


**Figure 3-4. Category 3 E-Stop Board and Teach Restrict Board on Control Rail**

The Control Rail contains the terminals for customer-supplied safety equipment. The terminal blocks TB4 and TB5 are for customer Emergency connections. The terminal block TB4 supplies the terminals for three additional Emergency Stop switches that are user-supplied.These switches are two-pole switches that are normally closed (N/C). The switches must comply with the safety requirements of all European and national standards. If the switches do not comply, the whole installation will not provide sufficient safety for Category 3.

**WARNING:** Do not use switches in the E-Stop circuit that do not comply with Category 3 requirements.

The specifications for user-supplied E-Stop and safety barrier switches are:

- two-pole (redundant) contacts, positive drive, per EN 60204:1992, Section 10.7.3
- minimum switching power 24 VA
- minimum switching voltage 24 VDC
- minimum switching current 1.0 A DC

The terminals for the user-supplied E-Stop and safety barrier switches and the names of the connectors and signals are given in Table 3-1. See also Table 3-1.

## Terminal Assignments for Customer E-Stops

The table below gives the terminal assignments of the terminal block TB4 on the Control Rail of the Security Panel. All contacts must be closed to enable High Power. Make sure that sufficient E-Stop switches are provided in the workcell, so they can be easily reached in an emergency.

Install a removable terminal block connector (supplied in the accessory kit) on TB4. Then connect to appropriate Customer E-Stops and other safeguards, as described in this section.

**WARNING:** Adept highly recommends using all of the provided additional Customer Emergency contacts to develop and operate a safe robot workcell that complies with the European Safety standards. The robot system must comply with Category 3 (per EN 954) which, according to our risk assessment, is the required category of safety for these Adept robot installations, per EU Directives.

**Table 3-1. Terminal Assignments on Terminal Block TB4 for Customer-Supplied E-Stop switches**

| Terminal on TB4 | Signal Name |
|---|---|
| TB4.1 | Customer E-Stop IN #1 |
| TB4.2 | Customer E-Stop IN #1 |
| TB4.3 | Customer Safety Barrier #1 |
| TB4.4 | Customer Safety Barrier #1 |
| TB4.5 | Customer Safety Barrier (Mute) #1 |
| TB4.6 | Customer Safety Barrier (Mute) #1 |
| TB4.7 | Customer E-Stop IN #2 |
| TB4.8 | Customer E-Stop IN #2 |
| TB4.9 | Customer Safety Barrier #2 |
| TB4.10 | Customer Safety Barrier #2 |
| TB4.11 | Customer Safety Barrier (Mute) #2 |
| TB4.12 | Customer Safety Barrier (Mute) #2 |

**NOTE:** If any of the signal pairs in the table above are not connected to customer safety devices, the contacts must be closed with a jumper, otherwise the E-Stop circuit is not closed and it is not possible to enable High Power. C-shaped metal jumpers are supplied in the accessory kit.

The Category 3 safety system provides two independent E-Stop loops, #1 and #2. The signals designated #1 and #2 represent pairs of signals from a two-pole switch. The #1 switches are in series with the number #1 contacts of the E-Stop switches on the VFP and the MCP. It is the same for the #2 contacts.

The Customer E-Stop IN #1 and #2 signals should be from a two-pole switch (or multiple two-pole switches). These contacts are for additional customer E-Stop switches or circuitry, for example light curtains, or pressure-sensitive mats. They would open the E-Stop circuit and shut down High Power when activated.

The Customer Safety Barrier #1 and #2 connectors should be from one or more two-pole switches. All the switches that are mounted on safety barriers and safety gates should be installed in series, making two separate loops. Then they are connected to the Customer Safety Barrier #1 and #2 input terminals on TB4.

Between the Customer Safety Barrier #1 and #2 (Mute) connectors, the same type of switch should be installed as between the connectors described above. In Automatic mode this switch or series of switches has the same function as the normal Customer Safety Barrier #1 and #2 connectors, but in Manual mode they are not connected to the chain of E-Stops. In Manual mode these connectors are muted (bypassed) by the control system. This allows you to open an access door to the robot workcell in Manual mode, if these limit switches are installed to the Customer Safety Barrier #1 and #2 (Mute) contacts.

## Voltage-Free Contacts for Monitoring E-Stop Circuitry (Passive E-Stop)

Adept provides voltage-free contacts (passive E-Stop) on TB5 for monitoring the emergency circuitry. The Passive E-Stop output uses positive-drive electro-mechanical relays that the customer can use to monitor the E-Stop circuit. Many safety standards do not permit electronic control of E-Stop signals, therefore the passive E-Stop output is often required to ensure that the user's equipment is shut down if the E-Stop circuit is activated.

The Passive E-Stop output should also be used to control any other user devices in the workcell that need to be stopped in an emergency. Such devices might include other moving equipment such as conveyor belts, indexing or transfer devices, pneumatic systems, etc.

The specifications for the relays in the passive E-Stop circuit are:

- maximum switching power = 250VA (volt amps)/5W
- maximum switching voltage = 230 Volts AC, 300 Volts DC
- maximum switching current = 2A

**CAUTION:** The power through the relay must not exceed 250VA/5 W.

The user can monitor the condition of the E-Stop circuitry with separate pairs of voltage-free contacts. The names of these two pairs of contacts are Customer Estop #1 OUT and Customer Estop #2 OUT. These contacts are closed if the E-Stop loop is closed and open if the E-Stop loop is open.

The Customer System Power voltage-free contacts are especially for monitoring the condition of AC power at the controller. The contacts are located in the VFP System Power switch.

The terminals for the Customer Manual Mode #1 and Customer Manual Mode #2 voltage-free contacts are two switches that are open in Automatic mode and closed in Manual mode. These contacts can be used to shut off workcell peripherals (conveyors, feeders, PLCs, network interfaces) when programing the robot in Manual mode. When used in this fashion, the MCP becomes the single point of control for the robot.

The Customer Safety Relay IN N/C (normally closed) Feedback Contacts must be closed with a jumper, if they are not used. These contacts must be used to check user-supplied relays in the E-Stop circuit, for example if there is relay contact in the Emergency Circuit instead of a E-Stop switch.

The terminals for the passive E-Stop and related signals are on terminal block TB5. The following table gives the terminal assignments and the signal names.

**Table 3-2. Terminal Assignment On Terminal Block TB5 for Passive E-Stop Contacts**

| Terminal | Signal Name |
|---|---|
| TB5.1 | Customer E-Stop #1 OUT, Voltage-Free Contacts |
| TB5.2 | Customer E-Stop #1 OUT, Voltage-Free Contacts |
| TB5.3 | Customer E-Stop #2 OUT, Voltage-Free Contacts |
| TB5.4 | Customer E-Stop #2 OUT, Voltage-Free Contacts |
| TB5.5 | Customer System Power On OUT, Voltage-Free Contacts[a] |
| TB5.6 | Customer System Power On OUT, Voltage-Free Contacts[a] |
| TB5.7 | Customer Manual Mode #1 OUT, Voltage-Free Contacts |
| TB5.8 | Customer Manual Mode #1 OUT, Voltage-Free Contacts |
| TB5.9 | Customer Manual Mode #2 OUT, Voltage-Free Contacts |
| TB5.10 | Customer Manual Mode #2 OUT, Voltage-Free Contacts |
| TB5.11 | Customer Safety Relay IN Feedback Contacts (N/C) |
| TB5.12 | Customer Safety Relay IN Feedback Contacts (N/C) (Pin 11 and 12 Jumper closed if not used) |

[a] The Customer System Power On OUT contacts are controlled by the System Power switch on the VFP. When this switch is on, the contacts are closed. The System Power signal can be used to control auxiliary equipment. If more than 2 amps are required, this signal should be used to control a contactor. Note: the VFP System Power switch also controls the power relay inside the Adept MV-8 or MV-19 controller.

## Digital Inputs and Outputs of the System Input/Output (SIO) Module

The digital input and output signals of the System Input/Output (SIO) Module (in the Adept MV controller) are wired to the terminal blocks TB1 and TB2 on the Security Panel, see Figure 3-4. Eleven input and five output channels are available. (The SIO module supports 12 input and 8 output channels, however 1 input and 3 outputs are used by the Category 3 safety system, and are not available to users.)

### Input Signals

The terminal blocks TB1 and TB2 handle the digital input signals 1001 to 1011. Each channel has an input and a corresponding return line. Refer to Table 3-3 for input specifications. The locations of the signals on the terminal blocks are given in Table 3-4.

**Table 3-3. DIO Input Specifications (SIO module) on the Security Panel**

| | |
|---|---|
| Operational voltage range | 0 to 24 VDC |
| "Off" state voltage range | 0 to 3 VDC |
| "On" state voltage range | 10 to 24 VDC |
| Typical threshold voltage | $V_{in}$ = 8 VDC |
| Operational current range[a] | 0 to 20 mA |
| "Off" state current range[a] | 0 to 1.2 mA |
| "On" state current range[a] | 7 to 20 mA |
| Typical threshold current, per channel[a] | 10 mA |
| Impedance ($V_{in}/I_{in}$) | 1.3 KΩ minimum |
| Current at $V_{in}$ = +24 VDC | $I_{in} \leq 20$ mA |
| Turn on response time (hardware)<br>Software scan rate/response time | 5 µsec maximum<br>16 ms scan cycle/ 32 ms max response time[b] |
| Turn off response time (hardware)<br>Software scan rate/response time | 5 µsec maximum<br>16 ms scan cycle/ 32 ms max response time[b] |

[a] the input current specifications are provided for reference; voltage sources are typically used to drive the inputs.

[b] 2 ms response time (minimum) for fast inputs 1001 to 1003, depending on program task configuration, when used with V+ INT.EVENT instruction.

**Table 3-4. Digital Input Signal Assignments on Terminal Blocks TB1 and TB2**

| Terminal Block | Terminal | Signal | Terminal | Signal |
|---|---|---|---|---|
| TB1 | 1 | 24 V/1 Amp | 2 | 24 V return |
| TB1 | 3 | Input 1001 | 4 | 1001 return |
| TB1 | 5 | Input 1002 | 6 | 1002 return |
| TB1 | 7 | Input 1003 | 8 | 1003 return |
| TB1 | 9 | Input 1004 | 10 | 1004 return |
| TB1 | 11 | Input 1005 | 12 | 1005 return |
| TB2 | 1 | Input 1006 | 2 | 1006 return |
| TB2 | 3 | Input 1007 | 4 | 1007 return |
| TB2 | 5 | Input 1008 | 6 | 1008 return |
| TB2 | 7 | Input 1009 | 8 | 1009 return |
| TB2 | 9 | Input 1010 | 10 | 1010 return |
| TB2 | 11 | Input 1011 | 12 | 1011 return |

**NOTE:** Digital Input signal 1012 is not available because it is used for the Category 3 safety system.

### Output Signals

The terminal block TB3 handles the digital output signals 0001 to 0005. Refer to Table 3-5 for output specifications. The locations of the signals on the terminal block are given in Table 3-4. The SIO provides separate + and – connections for each channel (no internal common connections.) This allows you the choice to wire for current-sourcing or current-sinking mode as required.

Each output channel (circuit) should be connected to only one output device. Each output circuit is short-circuit protected.

**Table 3-5. DIO Output Specifications (SIO module)**

| | |
|---|---|
| Operating voltage range | 0 to 24 VDC |
| Operational current range, per channel | $I_{out} \leq 100$ mA |
| $V_{drop}$ across output in on condition | $V_{drop} \leq 0.85$ V at 100 mA<br>$V_{drop} \leq 0.80$ V at 10 mA |
| Output off leakage current | $I_{out} \leq 600$ µA |
| Turn on response time (hardware)<br>Software scan rate/response time | 3 µsec maximum<br>16 ms scan cycle/ 32 ms max response time |
| Turn off response time (hardware)<br>Software scan rate/response time | 200 µsec maximum<br>16 ms scan cycle/ 32 ms max response time |

**CAUTION:** The above specifications for the digital inputs and outputs on the SIO module are different than the specifications for a DIO module. Specifically, the SIO output current is limited via short circuit protection to 100 mA per channel, whereas the DIO output is rated at 400 mA.

**Table 3-6. Digital Output Signal Assignments on Terminal Block TB3**

| Terminal Block | Terminal | Signal | Terminal | Signal |
|---|---|---|---|---|
| TB3 | 1 | 24 V/1 Amp | 2 | 24 V return |
| TB3 | 3 | Output 0001+ | 4 | Output 0001– |
| TB3 | 5 | Output 0002+ | 6 | Output 0002– |
| TB3 | 7 | Output 0003+ | 8 | Output 0003– |
| TB3 | 9 | Output 0004+ | 10 | Output 0004– |
| TB3 | 11 | Output 0005+ | 12 | Output 0005– |

**NOTE:** Digital Output signals 0006 to 0008 from the SIO module are not available because they are used for the Category 3 safety system.

# Commissioning the System 4


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## 4.1 Introduction

This chapter covers commissioning, or putting into service, the Adept robot system. This includes verifying that the installation is complete, starting and stopping the robot, and how to move the robot with the MCP. In a system with the Manual Mode Safety Package, you must run the Safety Utility program (see Appendix C) to verify that the E-Stop system, both Adept-supplied and customer-supplied equipment, is connected and working correctly.

## 4.2 Check Of Physical Connections

### Physical Connections

Before turning on the controller and enabling High Power, make sure that the following cables are installed correctly. See Chapter 2 for installation instructions.

- robot to power chassis
- robot to controller
- robot to Security Panel
- controller to power chassis
- controller to Security Panel
- power chassis to Security Panel
- VFP to controller, Security Panel and MCP

Make sure you have installed proper safeguards and E-Stop circuits as described in Chapter 1 and Chapter 3.

**CAUTION:** Ensure that all screws holding the amp modules and blank panels in the power chassis are securely fastened. If they are loose, power to the robot cannot be enabled.

Make sure that the controller is connected to the correct AC power source. See Chapter 2 for details about the power requirements of the devices.

## 4.3 VFP Operating Modes

Adept robots have two different operating modes.The VFP incorporates a 2-position rotary keyswitch marked MANUAL and AUTO that controls whether the robot is operating in Manual or Automatic mode. For safety reasons, High Power is automatically disabled when the operating mode is changed.

### Manual Operating Mode

In the MANUAL position of the keyswitch, robot motion can be initiated only from the Manual Control Pendant (MCP). In Manual mode it is not possible to initiate a motion with the system keyboard. This protects the operator in the workcell from unexpected motions of the robot.

In Manual mode the maximum speed of the Tool Center Point and the joints of the robot is reduced to 250 mm per second (10 ips). Also, the motors run at reduced torque. If the robot tries to move with a higher speed, sensors in the robot and the power amplifiers will detect this fault and turn off High Power to the power chassis.

See section 1.13 on page 13 for a description of safety equipment for an operator who is working in the robot workcell.

In Manual mode the contacts of the Customer Safety Barrier (Mute) are muted and the safety function of these contacts are disabled. This permits a skilled operator to enter the workcell while High Power is enabled.

### Automatic Operating Mode

The AUTO position of the operating keyswitch permits computer control of the robot. A program that is currently running the robot or motion device may cause it to move at times or along paths you may not anticipate. When the amber HIGH POWER light and the white PROGRAM RUNNING light on the VFP are illuminated, do not enter the workcell because the robot or motion device might move unexpectedly.

**WARNING:** Impact Hazard!
In Automatic mode no personnel are allowed to stay in the workcell. The robot can move at high speeds and exert considerable forces.

**CAUTION:** The LAMP TEST button on the VFP allows you to check the HIGH POWER light and the PROGRAM RUNNING light on the VFP. Adept recommends checking the two lights periodically, prior to entry into the workcell.

**NOTE:** The MCP can be used in Automatic (COMP) and in Manual (MAN) mode. For example, it is possible to calibrate the robot, or to enable High Power with the MCP in Automatic mode.

## 4.4 Using the Brake Release Button

### Brakes

The robots have fail-safe spring-actuated air release brakes on Joints 1, 2, and 3. (The AdeptThree-MV also has a brake on Joint 4.) These brakes are on whenever High Power is off. The brakes are intended primarily to restrict arm movement when high power is off, but they also assist in stopping robot motion when the Emergency Stop circuitry is activated or when there is a robot motion error. These brakes are not designed to be used as a routine method of stopping robot motion.

### Brake Release Button

Under some circumstances you may want to manually position the arm without turning on High Power. For such instances, a Brake Release button is located on the rear of the base (see Figure 4-1).

> **NOTE:** To use the Brake Release button you must disconnect the User-to E-Stop/Teach Restrict cable at the User connector on the Arm Signal cable. Then you must install the User Brake Release Jumper on the Arm Signal cable.
>
> When you are finished using the Brake Release button you must remove the Jumper and reconnect the User-to E-Stop/Teach Restrict cable to enable the safety features of the Security Panel.

When the User Brake Release Jumper is installed and when system power is on, pressing the Brake Release button releases the brakes, which allows movement of the arm. If this button is pressed while High Power is on, High Power will automatically shut down.

**CAUTION:** When the Brake Release button (or Remote Brake Release switch) is pressed, the quill (Joint 3) may drop to the bottom of its travel. To prevent possible damage to the equipment, make sure that the quill is supported while releasing the brake and verify that the end effector or other installed tooling is clear of all obstructions.

### Remote Brake Release Connection

The Brake Release can be operated remotely by connecting to the remote circuit located next to the Brake Release button (see Figure 4-1). You can install a mini-dual banana plug (ITT Pomona part number 2224-1, or equivalent) in the socket next to the Brake Release button. Construct a circuit with a momentary-contact switch and connect that to the banana plug. This circuit will perform like the normal Brake Release button described in the previous section, and the same cautions must be observed. As stated in the Note above, you must install the User Brake Release Jumper on the Arm Signal cable before using the Remote Brake Release feature.

**CAUTION:** The Remote Brake Release is for manual use only. It should not be incorporated into automatic acting circuits or systems. A momentary switch must be used for the remote brake release (i.e., no permanent acting N/C or N/O switches). The brakes are not designed to be used as a routine method of stopping robot motion.

**NOTE:** The Remote Brake Release connector is not available on the Adept PackOne robot.

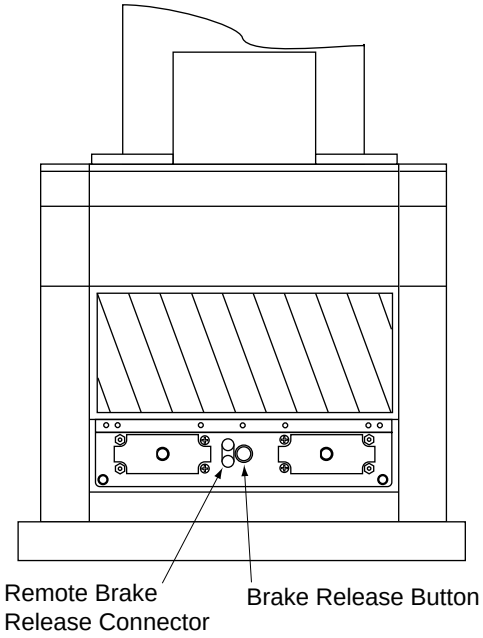


**Figure 4-1. Robot Base Showing Brake Release Button and Connector**

## 4.5 Description of the Manual Control Pendant (MCP)

The MCP assists the operator in teaching robot locations to be used in application programs. The MCP is also used with custom applications that employ "teach routines" that pause execution at specified points and allow an operator to teach or re-teach the robot locations used by the program. The Adept AIM software system makes extensive use of the pendant for teaching robot locations.

A description of the necessary basic operations with the MCP, such as enabling High Power, calibration, and moving the robot, follows in the next sections.

### How to Hold the MCP

The pendant has a palm-activated switch that is connected to the emergency stop circuitry of the Security Panel. Whenever this switch is released, High Power is turned off. To operate the MCP, put your left hand through the opening on the left-hand side of the pendant and use your left thumb to operate the pendant speed bars. Use your right hand for all the other function buttons.

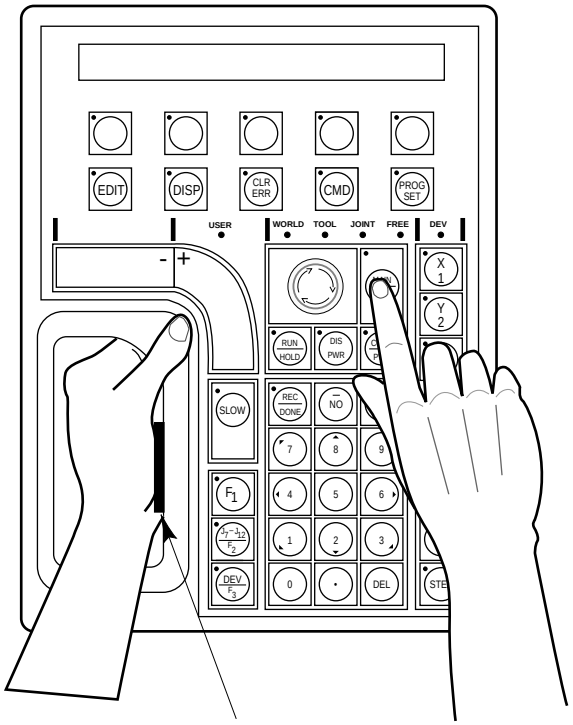


**Figure 4-2. Holding the MCP**

**NOTE:** The MCP must be stored in the MCP cradle to close the Hold-to-Run switch when it is not being held.

## Description of Buttons on the MCP

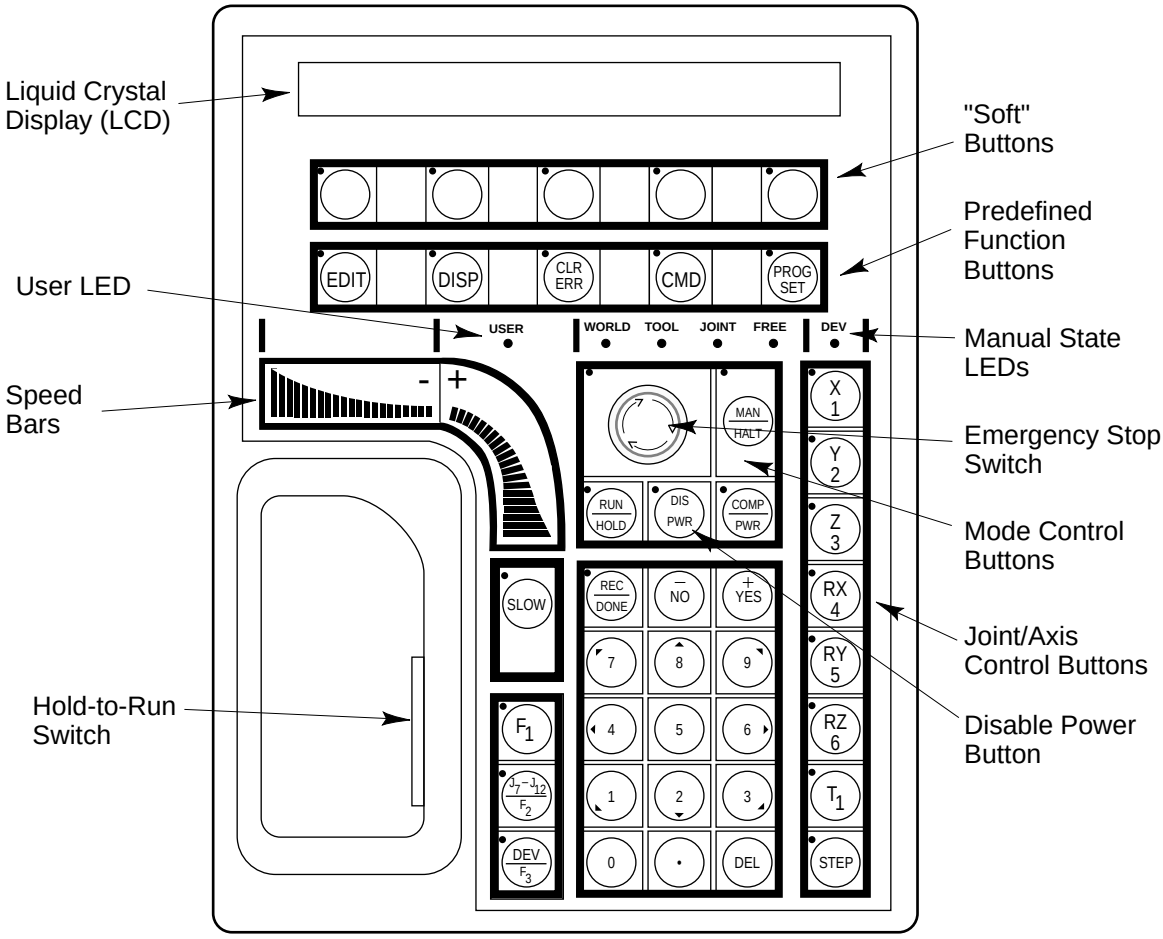


**Figure 4-3. MCP Layout**

### Mode Control and Joint/Axis Control Buttons

The mode control and joint/axis control buttons are used to control the robot from the pendant.

### Speed Bars

The speed bars and slow button are used primarily to move the robot when it is in MCP Manual mode.

> **NOTE:** The Step button on the lower right corner of the MCP is used to step through motions in a V+ program. See the *V+ 11.3 Release Notes* for details.

## 4.6 How to Stop a Robot in Manual Mode

There are several ways to stop the motion of a robot. The fastest way to stop the motion of a robot is to press an Emergency-Stop button. The robot will stop its motion immediately. Use a Emergency-Stop button only in emergency situations. The normal way is to press the DIS PWR button on the MCP or to release the speed bars on the MCP. The robot will stop after the actual motion.

Ways to stop the motion of a robot:

- Press the Emergency-Stop button on the MCP or another Emergency-Stop button, but only in emergency situations.
- Release the Hold-to-Run switch to shut off High Power.
- Release the Speed Bars on the MCP.
- Press the DIS PWR (Disable Power) button on the MCP.
- Press the HIGH POWER ON/OFF button on the VFP.

**NOTE:** If the robot or end-effector are bumped or jarred in Manual mode while High Power is on, an E-Stop could be triggered because of the Teach Restrict sensor in the outer link.

**CAUTION:** Press an Emergency-Stop button or release the Hold-to-Run switch only in emergency situations. In normal operations, stop the robot by releasing the speed bars or pressing the Disable Power button.

## 4.7 How to Start the Robot

Before a robot motion can be initiated, High Power must be turned on and the robot must be calibrated.

### Enable High Power with the MCP

#### In Automatic Mode

Follow the steps to enable High Power in Automatic mode with the MCP:

**NOTE:** If High Power is on and you release the Hold-to-Run switch on the MCP, the system recognizes an emergency stop signal and will turn off High Power immediately.

1. Turn on the power switches on the controller and the power chassis.
2. Set the VFP System Power switch into the position I, to turn on system power.
3. Verify that all Emergency-Stop switches are pulled out and all access doors to the workcell are closed.

**WARNING:** Impact Hazard!
In Automatic mode no personnel are allowed to enter or stay in the workcell. The robot can move at high speeds and exert considerable force.

4. Set operating keyswitch to AUTO and the other keyswitch to LOCAL.
5. Press the "COMP/PWR" button on the MCP.
6. Press the blinking "HIGH POWER ON/OFF" button on the VFP within 10 seconds.[1]

   **NOTE:** In Automatic mode the V+ operating system may take approximately 8 seconds to complete the High Power sequence.

### In Manual Mode

Follow the steps to enable High Power in Manual mode with the MCP:

**NOTE:** If High Power is on and you release the Hold-to-Run switch on the MCP, the system recognizes an emergency stop signal and will turn off High Power immediately.

1. Turn on the power switches on the controller and the power chassis.
2. Set the VFP System Power switch into the position I, to turn on system power.
3. Verify that all Emergency-Stop switches are pulled out and all access doors to the workcell are closed.
4. Set operating keyswitch to MANUAL and the other keyswitch to LOCAL. For added safety, remove the keys from the keyswitches.
5. Press the "COMP/PWR" button on the MCP.
6. Release the Hold-to-Run switch, as instructed by a message on the MCP display, and then close the switch again. This step is done to check for proper operation of the Hold-to-Run switch. This step is not required in Automatic mode.
7. Press the blinking "HIGH POWER ON/OFF" button on the VFP within 10 seconds.[1]

   **NOTE:** In Manual mode the V+ operating system may take approximately 20 seconds to complete the High Power sequence.

To re-enable High Power after pressing the MCP emergency stop button, turn the emergency stop button to the right (clockwise). The switch is spring loaded and will return to its normal position. Depress the Hold-to-Run switch. High Power can now be re-enabled by pressing the COMP/PWR button (mode control group) and the HIGH POWER ON/OFF push button on the VFP.

## Calibration of the Robot with the MCP

The robot can be calibrated only when High Power is enabled and Automatic mode is selected. If the robot is in Manual mode, you must switch to Automatic mode. After changing the operating mode, the controller shuts off High Power automatically. See the instructions above to enable High Power again.

[1] The default time out value is 10 seconds; this value can be changed using the CONFIG_C utility.

**WARNING:** Impact Hazard!
In Automatic mode no personnel are allowed to stay in the workcell. The robot can move at high speeds and exert considerable forces. Calibration involves limited robot motion. Observe all safety precautions.

1. Set the VFP operating keyswitch to the AUTO position and verify that the other keyswitch is in the LOCAL position. If necessary, re-enable High Power.
2. Press the CMD soft button to display functions.

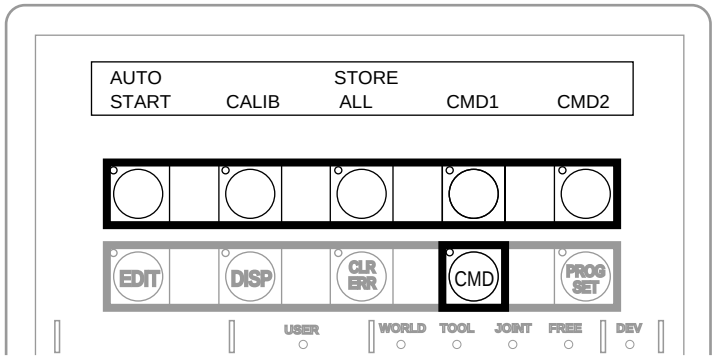


**Figure 4-4. Command (CMD) Function Button**

3. Press the soft button below the text CALIB in the display to start calibration.

Once the robot is calibrated you can move the robot. If High Power is turned off after calibration is complete, you have to Enable Power again, but you do not have to calibrate. If system power is turned off at the VFP, then you must Enable Power and Calibrate.

## 4.8 Using the Safety Utility

To complete the commissioning of the robot, you must run the Safety Utility. You cannot use the robot in Manual mode until the Safety Utility has been run and all tests have passed. See Appendix C for instructions. The Safety Utility requires you to define test locations for robot motions. Refer to section 4.9 for instructions on moving the robot.

## 4.9 Moving the Robot with the MCP

This section describes how to use the MCP to move the robot. You will need to use the MCP to perform some portions of the Safety Utility. Follow the steps on page 92 to enable High Power and to calibrate the robot. Do *not* enter the workcell. Leave the operating keyswitch in the AUTO position. Make sure that all access doors are closed and no person is in the workcell. Press the MAN/HALT button on the MCP to select the MCP Manual mode, then see the following descriptions.

**WARNING:** Impact Hazard!
Only a robot operator with the qualifications and safety equipment given in section 1.11 on page 12 is allowed to work with the robot.

## MAN/HALT Button for Selecting Joint State

The MAN/HALT button changes the state being used to move the robot.

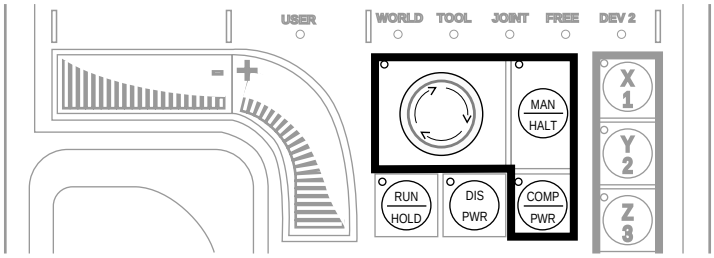


**Figure 4-5. Mode Control Buttons**

The system will remain in MCP Manual mode until High Power is turned off, or the COMP/PWR button is pressed.

When the MAN/HALT button is pressed the first time, the MCP will be in World state. Pressing the MAN/HALT button again selects the next state to the right (Tool, Joint, or Free), eventually wrapping back to the left-most state (World). If MCP Manual mode is terminated and re-entered (without turning off system power) the last active state is selected.

### Joint/Axis Control Buttons

The buttons on the far right side are the Joint/Axis control buttons, see Figure 4-3 on page 91. When the controller is in Manual mode, these buttons select which robot joint will move, or the coordinate axis along which the robot will move.

### Speed Bars

The speed bars are used to control the robot's speed and direction. The joint(s) that will move when the speed bars are pressed depends on the "state" selected with the MAN/HALT button. Press the speed bars with your left thumb. Pressing the speed bars near the outer ends will move the robot faster, pressing the speed bar near the center will move the robot slower. The maximum speed of the robot in Manual mode is 250 mm per second (10 ips).

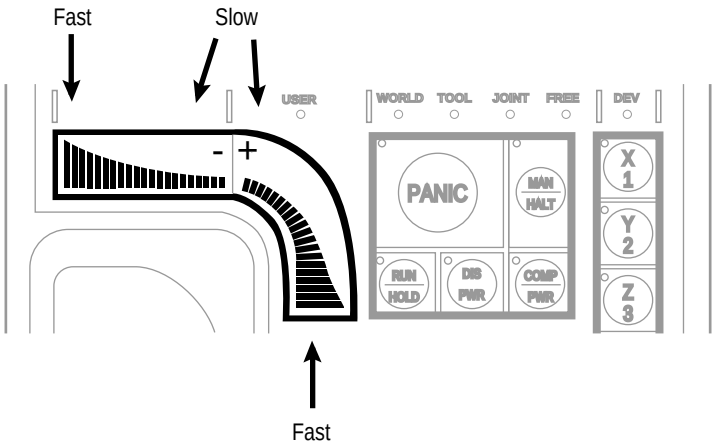


**Figure 4-6. Speed Bars**

## Selecting Joint State and Moving the Robot

Figure 4-7 shows a typical Adept SCARA robot with three rotational joints (Joints 1, 2, and 4) and one translational joint (Joint 3). Positive rotation of Joints 1 and 2 is counter-clockwise as viewed from above. Positive rotation of Joint 4 is clockwise as viewed from above. Positive movement of Joint 3 is downward. Before the speed bars will move a joint, the correct joint must be selected from the Joint/Axis control buttons.

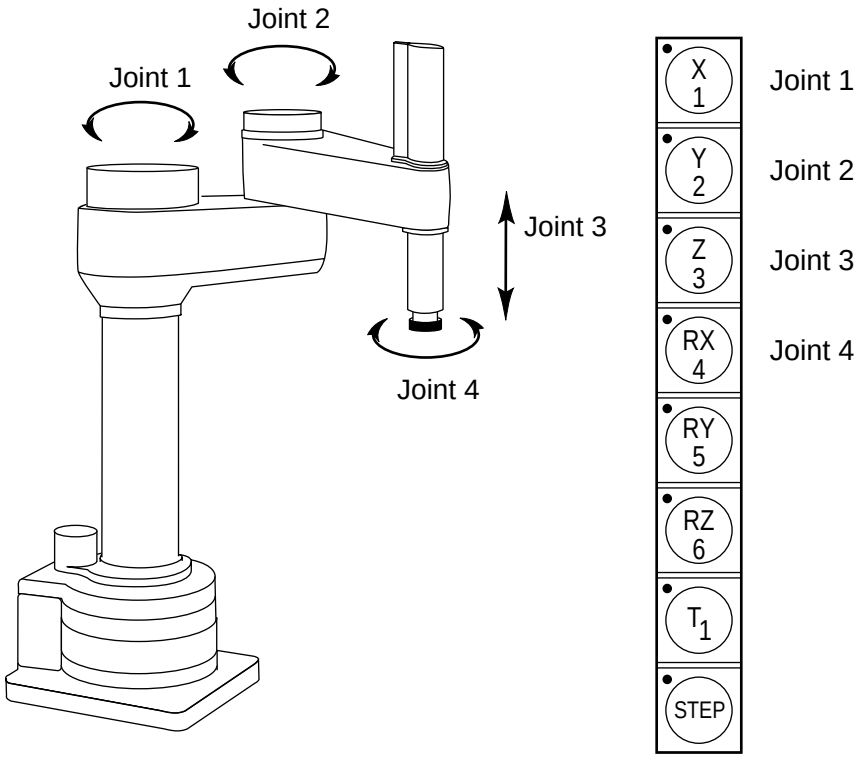


**Figure 4-7. Joint State (SCARA)**

In Joint State, only the selected joint moves. After the calibration of the robot, switching into Manual mode and re-enabling High Power, you must select the joint mode.

1. Press the MAN/HALT button to enable the MCP.

   The MCP is in the correct mode when:

   a. The LED on the MAN/HALT button is illuminated. If it is not illuminated press the MAN/HALT button.

   b. One of the manual state LEDs is also illuminated (the "Manual state" LEDs indicate the type of manual motion that has been selected, either World, Tool, Joint, or Free).

2. Press the MAN/HALT button (see Figure 4-5) several times until the JOINT LED is illuminated.

When the LED on the MAN/HALT button and the JOINT LED are lit, Joint state is selected and movement of a specified joint must be selected.

### Selecting and Moving Joint 1

Before you can move Joint 1, you must select it with the MCP. On the right side of Figure 4-7 you can see the buttons for selecting a joint in the Joint State. After pressing the X1 button that selects Joint 1, the LED on the button will turn on. Then you can move the robot with the speed bars.

> **NOTE:** The operator must keep pressing the Hold-to-Run button to retain High Power while working with the robot.

Press the positive speed bar until the robot starts moving. When it moves in one direction stop pressing the speed bar. Then press the minus speed bar and watch the robot. It must now move into the opposite direction. After you verified that the robot can move in both directions, you can release the speedbar.

### Selecting and Moving Joint 2

Press the Y2 button on the MCP to select Joint 2. After pressing the Y2 button the LED on it will turn on. The robot is ready to move Joint 2.

Press the positive speed bar until the robot starts moving Joint 2. When it moves stop pressing the speed bar. Then press the negative speed bar and watch the robot. It must move into the opposite direction. After you verified that the robot can move in both directions, you can release the speedbar.

### Selecting and Moving Joint 3

Press the Z3 button on the MCP to select Joint 3. After pressing the Z3 button the LED on it will turn on. The robot is ready to move Joint 3.

Press the positive speed bar. The robot quill must move in the direction of the floor. If you verified that the robot follows the instruction, then press the minus speed bar and check if the quill moves into the opposite direction.

### Selecting and Moving Joint 4

Press the RX4 button on the MCP to select Joint 4. After pressing the RX4 button the LED on it will turn on. The robot is ready to move Joint 4.

Press the positive speed bar until the robot starts moving. When it moves, stop pressing the speed bar. Then press the minus speed bar and watch the robot. It must move into the opposite direction. After you verified that the robot can move in both directions you can release the speedbar.

# 5 Maintenance


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## 5.1 Introduction

The AdeptOne-MV, Adept PackOne-MV and AdeptThree-MV robots require very little maintenance due to the direct-drive design. Joints 1 and 2 need no maintenance at all. This chapter describes the preventive maintenance procedures that are required to keep the robot system operating properly.

The Adept PackOne-MV robot requires additional maintenance relating external surface coating, rotary seal assemblies and cleaning information. Please refer to section 5.8 on page 109 for this maintenance information.

See Table 5-1 for a summary of the preventive maintenance procedures and guidelines on frequency.

**Table 5-1. Recommended Preventive Maintenance Schedule**

| Item | Recommended Schedule (hours) |
|---|---|
| Lubricate the upper and lower quill shaft | Every 3 months or ~1000 hours |
| Check all screws in robot cover plates and robot mounting stand | Monthly |
| Check all cable connections | Monthly |
| Drain robot compressed air filter moisture trap | Monthly |
| Check air filters on controller and power chassis | Monthly |
| Check lamps on VFP using Lamp Test button | Monthly |
| Run Safety Utility | Every six months |

**NOTE:** The frequency of these procedures will depend on the particular system, its operating environment, and amount of usage. Use the times in Table 5-1 as guidelines and modify the schedule as needed.

**WARNING:** The procedures and replacement of parts mentioned in this section should only be performed by skilled or instructed persons, as defined in section 1.11 on page 12. The access covers on the robot are not interlocked – turn off disconnect power if covers have to be removed.

## 5.2 Using the Safety Utility

Use the Safety Utility every six months to test the components of the Category 3 safety system. See Appendix C for instructions.

## 5.3 Robot Lubrication

The Joint-3 quill shaft requires periodic lubrication. The frequency of lubrication will depend on the operating environment and amount of usage. Initially, check the quill of the AdeptOne-MV, AdeptThree-MV and Adept PackOne-MVrobot once a week, recording the results with the intent of producing a schedule appropriate to the particular system, its environment, and usage. For the Adept PackOne-MV robot plan on lubricating every three months.

To check for adequate lubrication at the Joint-3 quill, run a finger along the quill. A thin film of grease should be present. If the shaft is dry, it needs lubrication.

### Recommended Grease for AdeptOne-MV /AdeptThree-MV Robot

Dow Corning MOLYKOTE BR2 PLUS,
a molybdenum disulfide based grease
(Dow catalog number 89570-81)

Adept part number: 85214-89570

**CAUTION:** Using improper lubrication products on the AdeptOne-MV or AdeptThree-MV robot can cause damage to the robot.

### Recommended Grease for Adept PackOne-MV Robot

Mobilux EP-2,
USDA H2 approved, extreme pressure grease

Adept part number: 85151-00001

**CAUTION:** Using improper lubrication products on the Adept PackOne-MV robot can cause damage to the robot. Use only a USDA H2 (or equivalent) approved grease.

### Lubricating the Upper Quill Shaft

Lubrication of the robot requires that the quill be moved while HIGH POWER is off. Use the Brake Release button at the rear of the base to release the brake allowing manual quill movement. See section 4.4 on page 88 for instructions on using the Brake Release button.

**CAUTION:** When the brake release button is pressed, the quill could drop to the bottom of its travel. To prevent possible damage to the equipment, make sure that the quill is supported while releasing the brake and verify that installed tooling is clear of all obstructions.

1. Turn off HIGH POWER to the robot.

2. Remove the quill cover (see Figure 5-1).
3. Press the brake release button and move the quill to its fully raised position. Inspect the upper quill shaft and remove any excess or accumulated grease.
4. Use a grease syringe to apply five lines of grease vertically on the exposed quill shaft. Each line should run from top to bottom and they should be evenly spaced around the shaft.

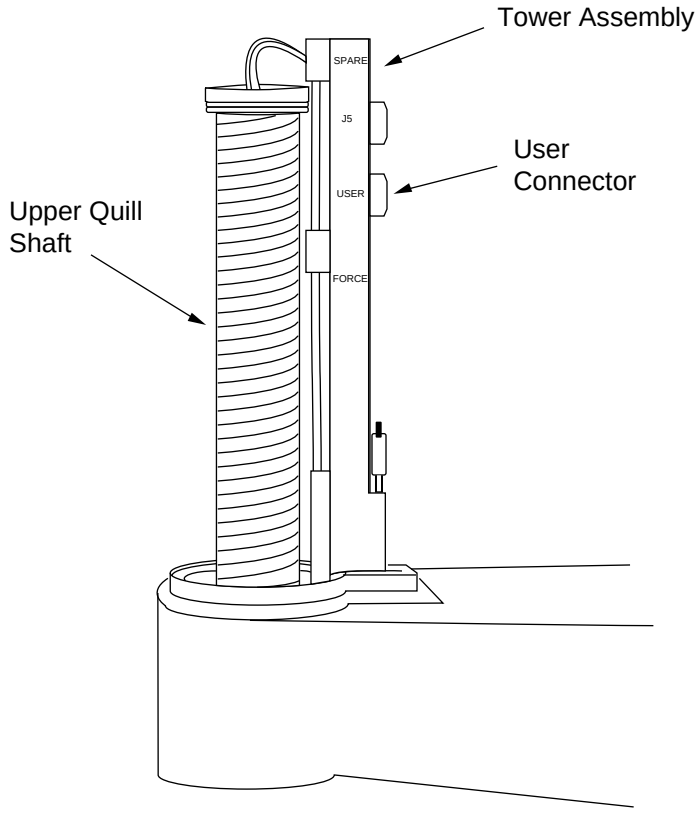


**Figure 5-1. Upper Quill Shaft**

**CAUTION:** When reinstalling the quill cover of a Adept PackOne-MV robot, you must reseal the bolts that secure the cover. Refer to the procedure in section 5.9 on page 111 for complete details.

## Lubricating the Lower Quill Shaft – AdeptOne-MV/ Adept PackOne-MV Robot

1. Move Joint 3 to the bottom of its travel.
2. **Adept PackOne-MV robot:**
   Remove the bellows by loosening the top and bottom clamps. Slowly pull the bellows down over the Joint 4 seal assembly.
3. The Joint 3 seal is a soft, rubber lip seal located as shown in Figure 5-2. Gently insert the tip of the syringe applicator underneath the seal and apply grease around the entire circumference of the shaft.
4. Apply three thin lines of grease vertically on the shaft with each line running from top to bottom and evenly spaced around the lower shaft.
5. With a small brush, spread the grease into a thin film covering the entire shaft surface, including the "V" groove.
6. Move Joint 3 slowly from the bottom to the top of its travel several times, then leave it in the middle of its travel. Use a cloth to wipe away any excess grease on the shaft or at the seal.
7. Replace the quill cover.
   **Adept PackOne-MV:**
   Be sure to reseal the bolts on the quill cover according to the resealing process listed in section 5.9 on page 111. Reinstall the bellows; see the following procedure for details and torque specs.

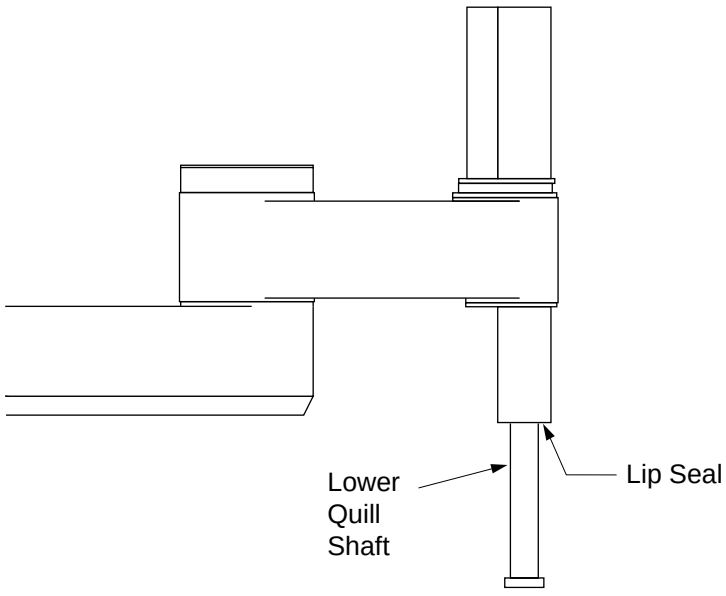


**Figure 5-2. Lower Quill Shaft and Lip Seal Location**

## Lubricating the Lower Quill Shaft – AdeptThree-MV Robot

1. Turn High Power off.
2. Move the quill to its fully-raised position.

**CAUTION:** The quill MUST be in the fully-raised position before lubricating. Improper quill positioning could result in excessive lubricant getting on the Joint 4 brake, which could cause its failure.

3. Using a 5/16-inch Allen wrench, remove the grease fitting access plug from the side of the Joint 4 housing. See Figure 5-3.
4. While looking through the access plug hole, rotate the quill until the zerk fitting is accessible.
5. Insert the tip of a grease gun and apply grease until excess grease squeezes out from the quill seal.
6. Remove the grease gun.
7. Reposition the quill to the bottom of its travel and wipe excess grease from the quill.
8. Replace the access plug.
9. Replace the quill cover.

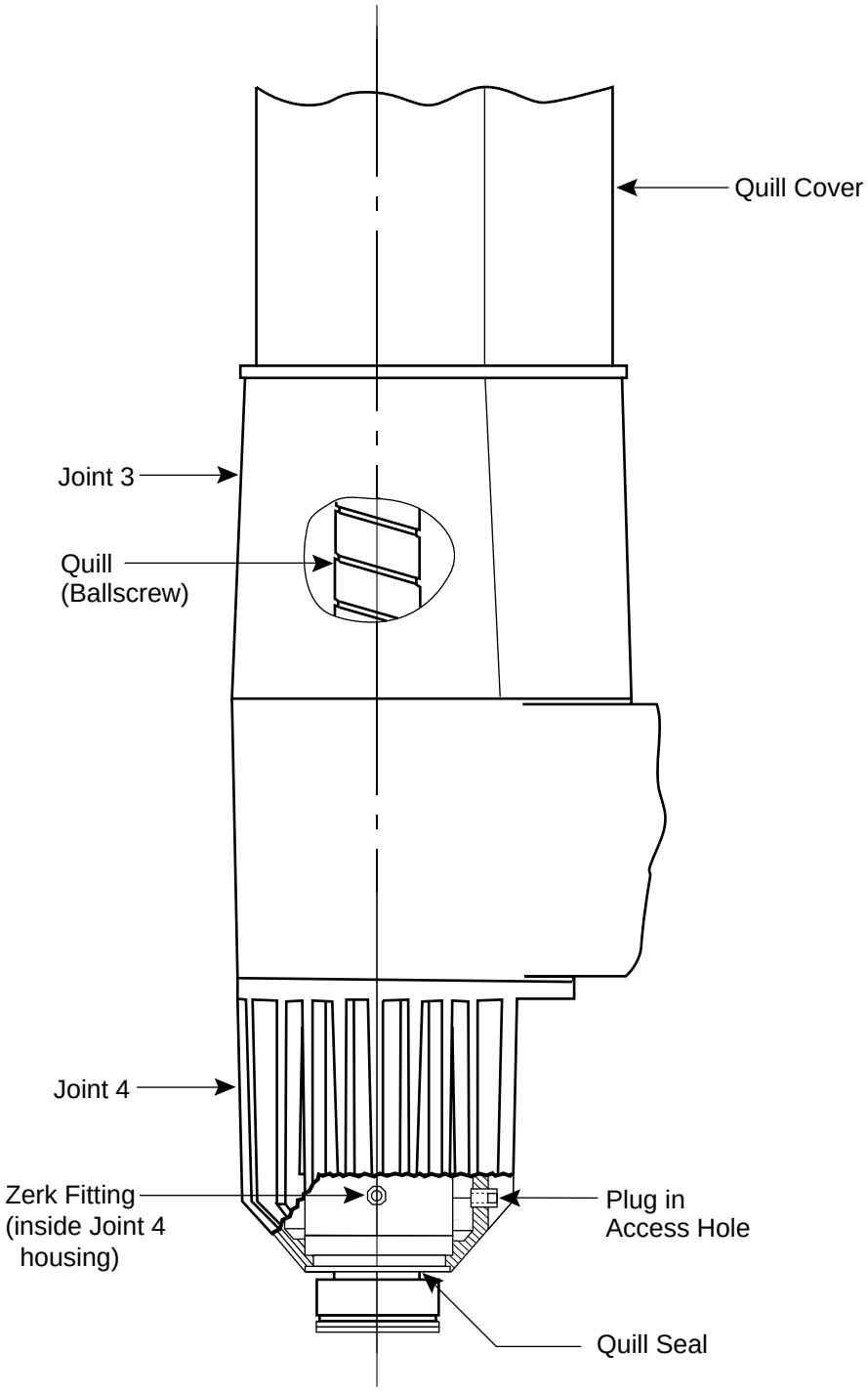


**Figure 5-3. Lubrication of the Lower Quill Shaft of the AdeptThree-MV Robot**

## 5.4 Check Robot Mounting Bolt Tightness

The robot mounting bolts should be checked periodically to make sure they are not loose. Also check the tightness of all cover plate screws and all the captive screws of the cables.

## 5.5 Joint 3 Bellows Replacement – Adept PackOne-MV

The protective bellows covering the quill shaft area will have to be replaced about every six months. Replacement bellows kits should be purchased from Adept; call Customer Service to order.

**CAUTION:** Inspect the bellows daily for cracks, splits, or any other signs of wear. Replace the bellows sooner than six months if you see any indications that moisture could get inside to the quill area.

1. Remove the existing bellows by loosening and removing the upper and lower clamps, then slowly pull the bellows down over the Joint 4 seal assembly.
2. Remove the upper and lower rubber band gaskets that sit under the clamps and bellows.
3. Install the new gaskets that come with the kit. Place the gaskets in the recessed grooves located on both clamping diameters.
4. Carefully install the new bellows, checking to see that both rubber band gaskets are centered in their respective grooves.
5. Install the clamps and tighten the screws to a torque of 3.39 Nm(30 in-lb) minimum.

# 5.6 Maintenance and Inspection of Air Filters

## Draining Moisture from AdeptOne-MV/AdeptThree-MV Robot Compressed Air Filter

The air filter on the compressed air inlet at the AdeptOne-MV and AdeptThree-MV robot base has a moisture trap that should be emptied periodically, depending on the quality of the air supply and the frequency of usage. The procedure to empty the trap is done with the air supply connected. To empty the trap, use a rag to push up on the bottom of the air filter.

If you have to empty water from the filter housing frequently, check the water content in your compressed air supply and consider using an air dryer. Moisture inside the robot can cause damage to mechanical, electrical, and pneumatic components.

## Maintaining Compressed Air Filter of Adept PackOne-MV Robot

### Draining Moisture from the Air Filter

Check the air filter housing on a daily basis for any buildup of water at the bottom of the housing. Drain any accumulated water by opening the knob at the bottom of the filter. If your air dryer is working properly, very little water should accumulate in the air filter.

### Replacing the Filter Cartridge

The air filter housing contains a replaceable coalescent filter cartridge. Replace the cartridge every six months. Order the replacement coalescent cartridges from:

Master Pneumatic - Detroit, Inc.
6701 Eighteen Mile Road
Sterling Heights, Michigan 48078
(313) 254-1000

- Filter Housing Model Number: FC100-2
- Replacement Cartridge Number: A103-133

## HyperDrive Robot Fan Filter Inspection and Cleaning

The fan filter on a HyperDrive robot is located on the base, see Figure 2-17. The fan filter must be inspected regularly and cleaned at the first sign of dust or dirt buildup. The filter must be inspected and cleaned at least once per month. Regular cleaning will prolong the life of the filter. If the filter becomes clogged or unusable for any reason, you will need to order a new air filter. The part number for the filter is 40320-20231.

1. Turn off High Power to the robot.
2. Lift the filter up by the tabs on the top edge.
3. Inspect the filter for dust or dirt particles. If cleaning is required, use compressed air to clean the filter.
4. Replace the cleaned air filter.

### Adept PA-4 Fan Filter Inspection and Cleaning

The air filter located on the front of the chassis should be inspected regularly and cleaned at the first sign of dust or dirt buildup. The filter must be inspected and cleaned at least once per month. Regular cleaning will prolong the life of the filter. If the filter becomes clogged or unusable for any reason, you will need to order a new air filter. The part number for the filter is 40330-11200.

**WARNING:** Dangerous voltages are present inside the power chassis. Turn off the power to the power chassis and protect it against an unauthorized return to service, before opening the front grill to inspect the air filter. Failure to observe this warning could cause injury or damage to your equipment.

1. Turn off the power to the power chassis and protect it against an unauthorized return to service.
2. Open the front grill by loosening two screws and swinging the grill out.
3. Pull the air filter out and inspect for dust or dirt particles. If cleaning is required, use compressed air to clean the filter.
4. Replace the cleaned air filter and secure the grill.

### Adept MV Controller Fan Filter Inspection and Cleaning

The air filter located on the front of the chassis should be inspected regularly and cleaned at the first sign of dust or dirt buildup. The filter must be inspected and cleaned at least once per month. Regular cleaning will prolong the life of the filter. If the filter becomes clogged or unusable for any reason, you will need to order a new air filter; the Adept part number is 40330-11190.

1. Turn off the controller and protect it against an unauthorized return to service.
2. Open the front grill by loosening two screws and swinging the grill out.
3. Pull the air filter out and inspect for dust or dirt particles. If cleaning is required, use compressed air to clean the filter.
4. Replace the cleaned air filter and secure the grill.

## 5.7 Check Lamps on VFP

Use the Lamp Test button on the external Front Panel to test the lamps once per month. Replace any lamps that are not working. Contact Adept Customer Service for replacement information.

# 5.8 Special Maintenance for Adept PackOne-MV Robot

## General Information

### Exterior Surface Coating

The coatings used on the exterior surfaces of the Adept PackOne robot are USDA approved polymer powder coatings. These are electrostatically sprayed, then baked on to each individual part prior to assembly. These coatings are not paint that can be applied after the robot is assembled.

The coatings are tough and durable but can be damaged if mistreated. Users, maintenance personnel, cleaning crews, etc., must take care to protect the robot surface from sharp or abrasive objects and strong chemical cleaning agents (such as sodium hydroxide.) If the surface is damaged to the extent where the base material is exposed, contact Adept Customer Service for information on possible rework.

### Rotary Seal Assemblies

The rotary seal assemblies used on the Adept PackOne robot are composed of carbon/graphite reinforced teflon seal elements which wear against precision ground shafts. These rotary seal assemblies are lubricated for life at the factory with a USDA H1 approved grease. No further maintenance or lubrication is required. During the initial wear-in period, some dry seal particles or seal wear particles mixed with grease may extrude from the seal-to-shaft interface. These particles should be carefully wiped away during the normal cleaning process.

### Fixed Seals

The removable access covers are sealed with flat, nitrile rubber gaskets. The permanent joints between mating parts are sealed with silicone adhesive. If these seals degrade or become worn due to physical abuse, chemical attack, etc., they should be repaired or replaced immediately. Please contact Adept Customer Service for further information.

## Cleaning Information

The Adept PackOne robot is designed to meet NEMA 4 and IP 55 requirements for low pressure water splashing. The Adept PackOne is not designed to be sprayed from close proximity with high pressure water nozzles. If high pressure water nozzles are used near the PackOne, the protective cover (supplied with the robot) must be installed to protect against errant spraying. In order to maintain compliance with the warranty, follow the procedures listed below and pay close attention to the Caution messages.

### Removing the End Effector for Cleaning

The end effector can be removed for a separate cleaning procedure; refer to the instructions that come from the manufacturer of the end effector. When the end effector is removed, you must plug the Open and Close air lines at the end of the quill so that no moisture can enter the robot through those lines.

### Washdown Procedure

**CAUTION:** The application of strong alkaline, acidic, or high chlorine cleaning chemicals may degrade the PackOne's surface finish. Cleanup with high pressure sprays, abrasive cleaning agents, and scouring pads may damage the PackOne's seals and surface finish. These practices are not recommended on the PackOne.

The PackOne is designed to withstand occasional errant exposure to high pressure sprays and caustic chemicals, and no damage should result from accidental high pressure spraying or cleaning chemical exposure.

Adept warranty coverage is not extended to seal, surface finish, and consequential damage caused by failure to observe recommended cleaning procedures and cautions. Regular cleanup procedures should follow the recommendations listed in this manual.

**WARNING:** Personnel working in the robot workcell must always wear safety equipment, see section 1.13 on page 13.

1. With High Power turned on, lower the quill to its fully extended position so the bellows folds are as open as possible.
2. Turn off High Power to the robot.
3. Make sure compressed air to the robot remains turned on so the internal air flow can work to dry out any internal condensation that may develop during cleaning.
4. Adept recommends that the robot be washed by hand using sponges, towels, or soft brushes and mild detergents or sanitation chemicals.
5. Rinse the robot with a low pressure, 0.06 Bar, 19 liters/minute (1 psi, 5 gpm), water hose, typical of a garden hose output.
6. Inspect the bellows, the outer exposed edges of all gaskets, and the rotary seal areas after every cleaning to look for signs of wear, chafing, abrasion, or other indications of problems.

### Installing Protective Cover

Install the supplied protective vinyl cover on the Adept PackOne before any high pressure spraying or strong chemical cleaning agents are applied to any equipment nearby. This protective cover shields the robot while other equipment is being cleaned.

### Drying Time Before Operation

Remove the protective cover after all high pressure spraying is complete. Allow the Adept PackOne to dry for 15 minutes before returning to operation.

## 5.9 Bolt Removal /Resealing Procedure – PackOne-MV Robot

The access cover bolts and screws on the Adept PackOne are hygienically sealed at the factory to prevent moisture entering the robot, as well as to avoid a crevice which would be unhygienic. If any bolts are loosened or removed, they must be resealed according to the procedure listed below.

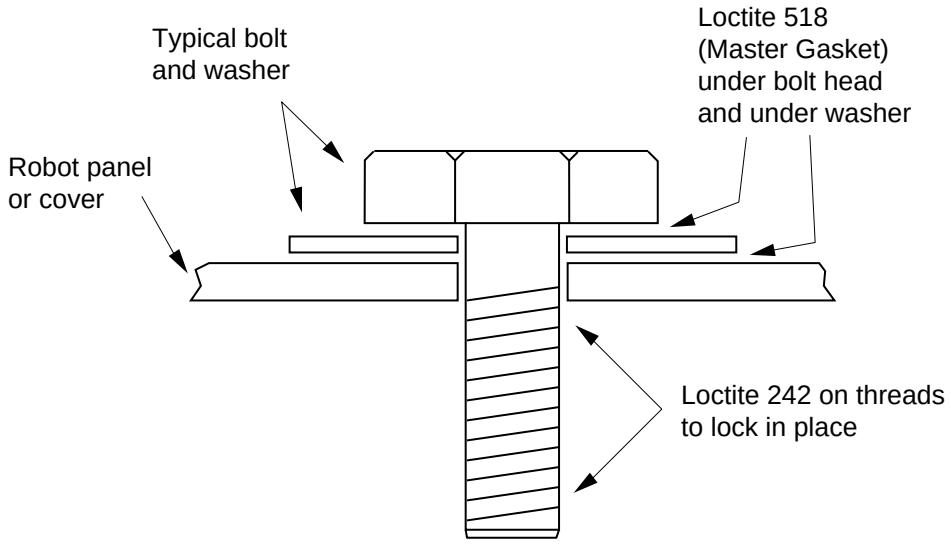


**Figure 5-4. Bolt Resealing Detail**

1. Clean off the old sealant from the bolt and the area around it.
2. Apply a thin coat of Loctite 242 to the bolt threads.
3. Apply a continuous bead of Loctite 518 (Master Gasket) to the under side of the washer and the bolt head.
4. Tighten the bolt to a torque of:
   - 50 in-lb (5.7 Nm) for 1/4-20
   - 30 in-lb (3.4 Nm) for 10-24
   - 15 in-lb (1.7 Nm) for 8-32
5. Wipe off any excess sealant after tightening.

**NOTE:** If an Adept Field Service engineer performs repairs to a PackOne at the customer site, prior to completing the work they will need to use a source of customer-supplied helium to do leak detection tests.

# 6 Technical Specification


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## 6.1 Dimensions

### Dimensions for AdeptOne-MV HyperDrive Robot

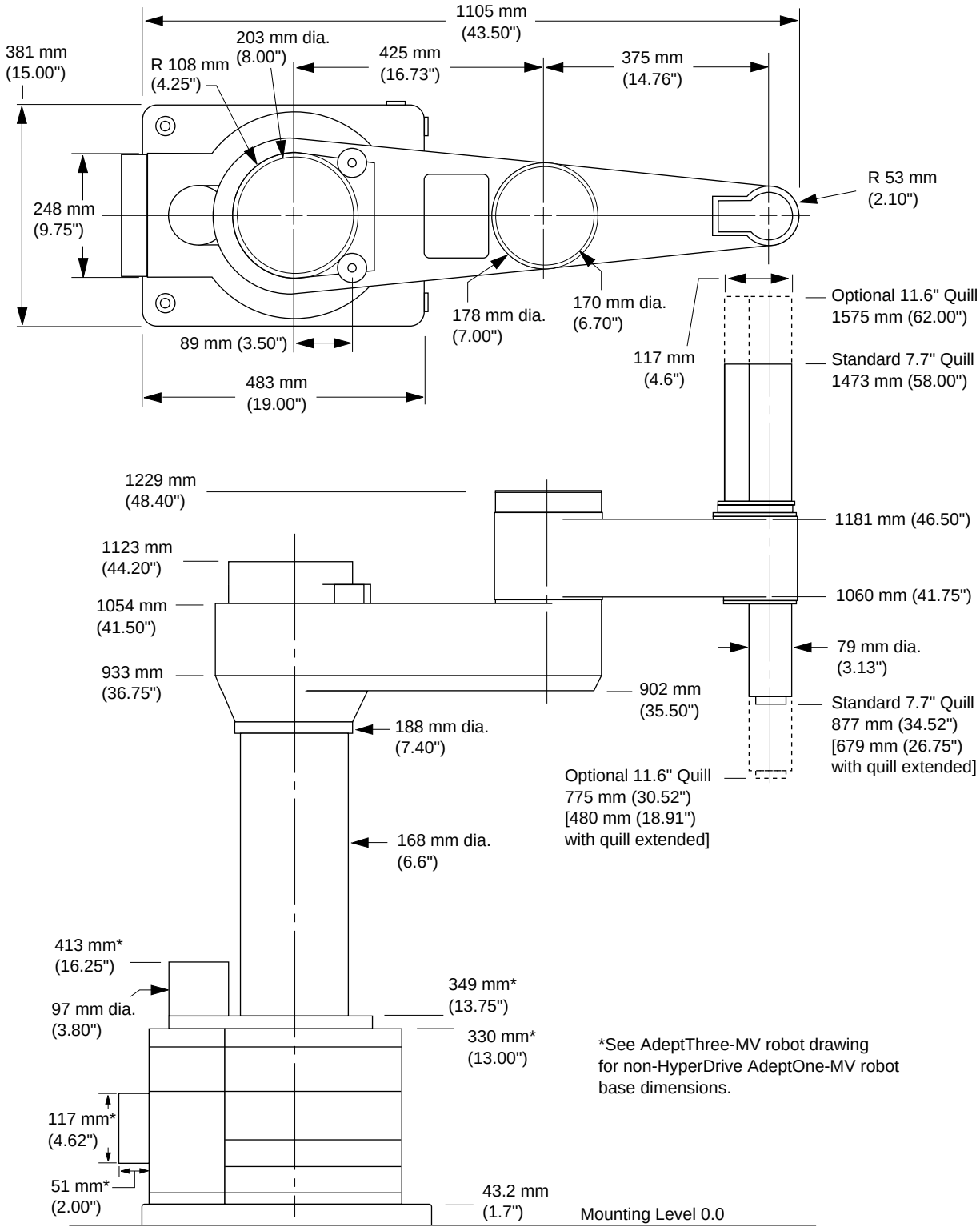



**Figure 6-1. AdeptOne-MV HyperDrive Robot Top and Side Dimensions**

## Dimensions for AdeptThree-MV Robot

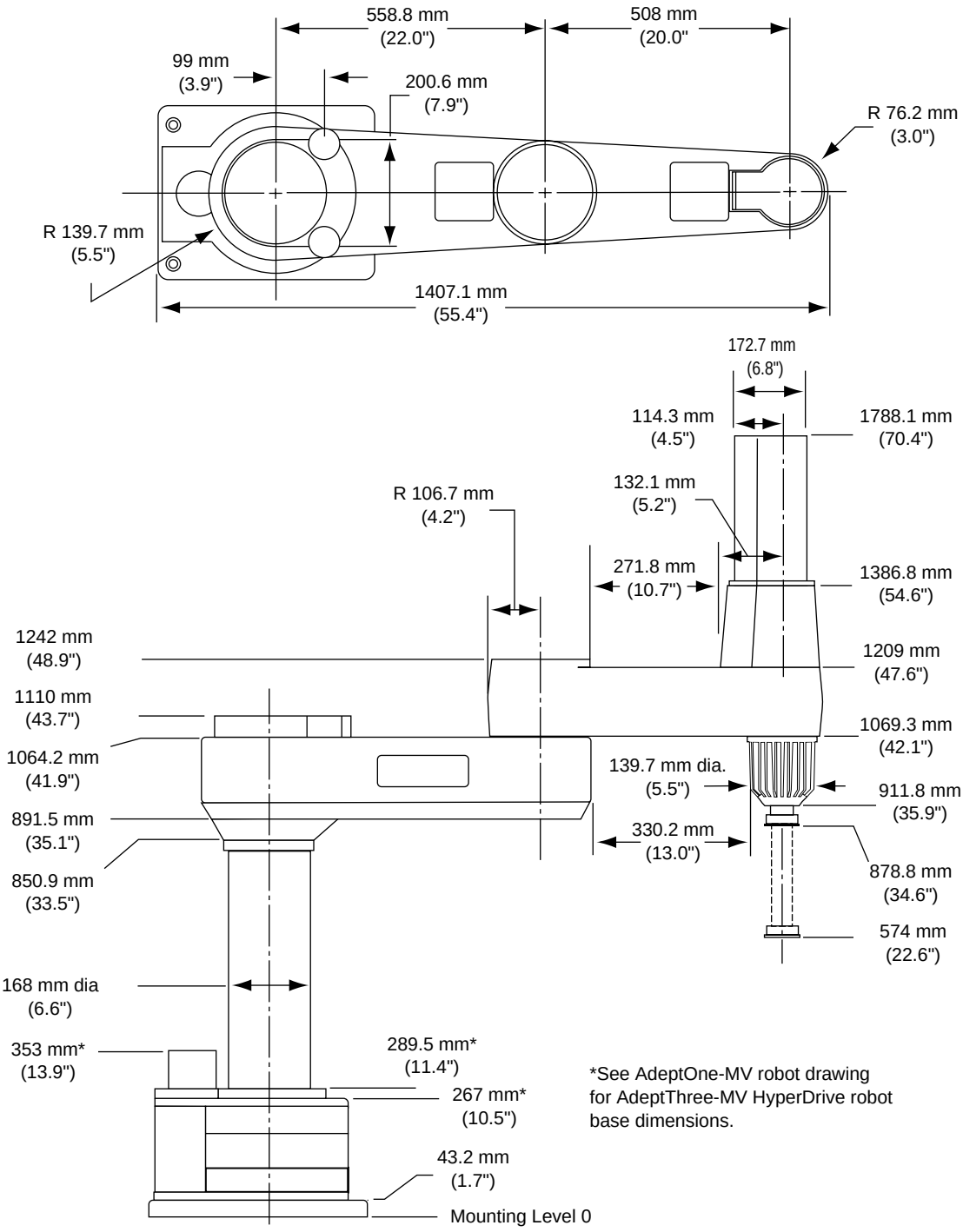



**Figure 6-2. AdeptThree-MV Robot Top and Side Dimensions**

## Dimensions for Adept PackOne-MV Robot

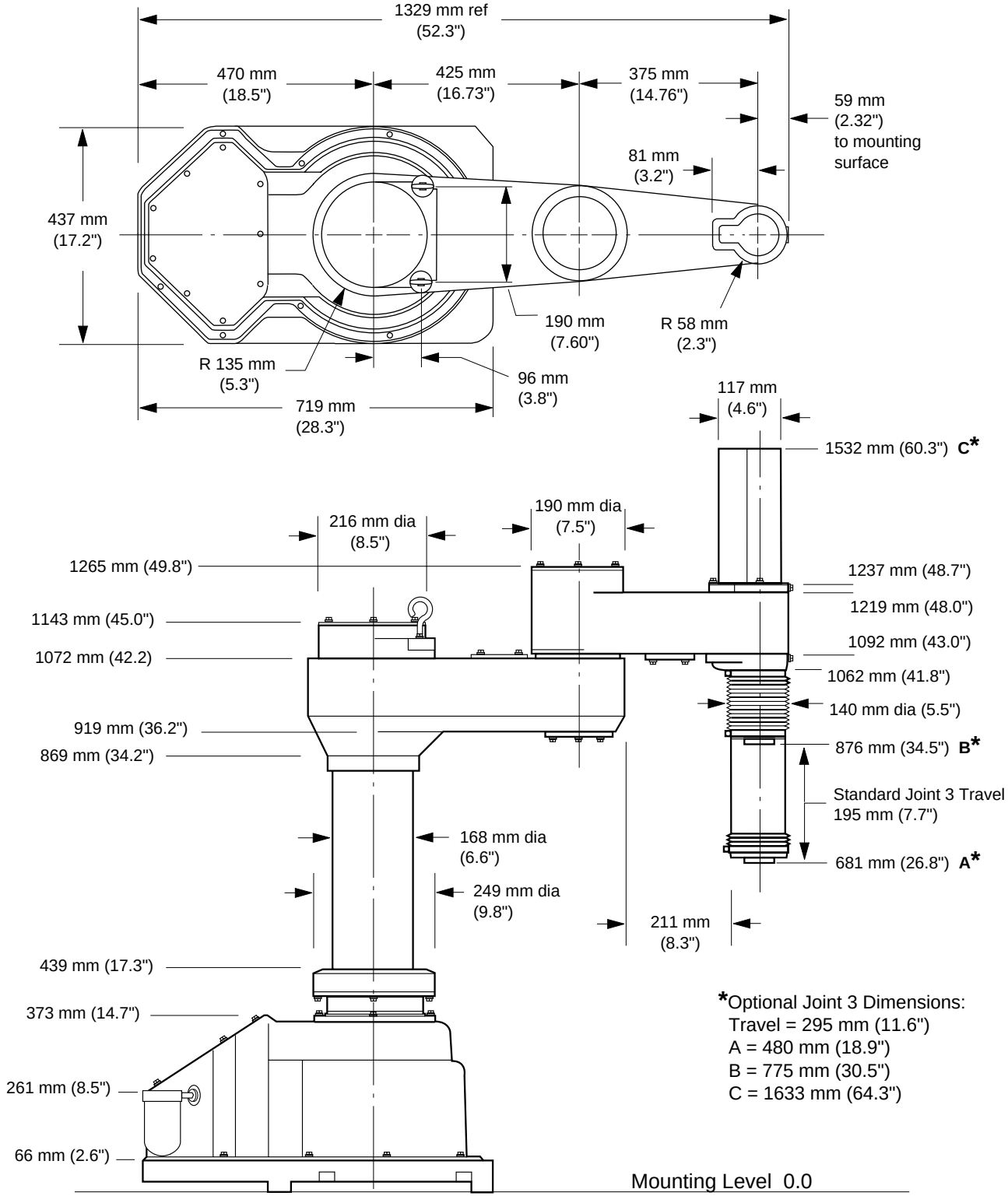



**Figure 6-3. Adept PackOne-MV Robot Top and Side Dimensions**

## Calibration Fixture Dimensions

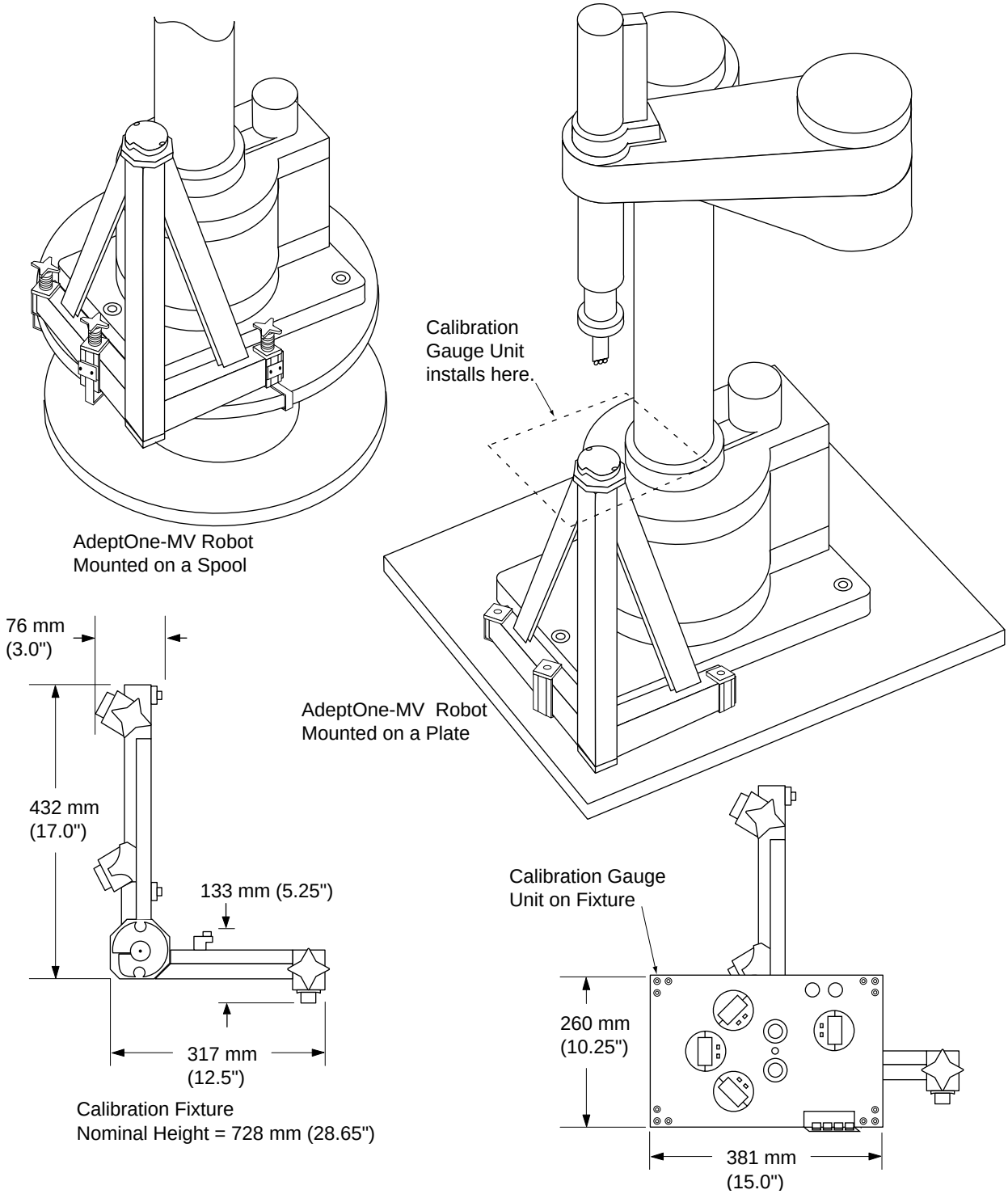



**Figure 6-4. AdeptOne-MV Robot with Calibration Fixture**

**NOTE:** The Calibration Fixture will have to be mounted to the robot as shown above if a joint encoder has to be replaced or other major repairs have to be performed. Leave adequate space in the workcell if possible.

## User (Quill) Flange Dimensions for AdeptOne-MV and AdeptThree-MV

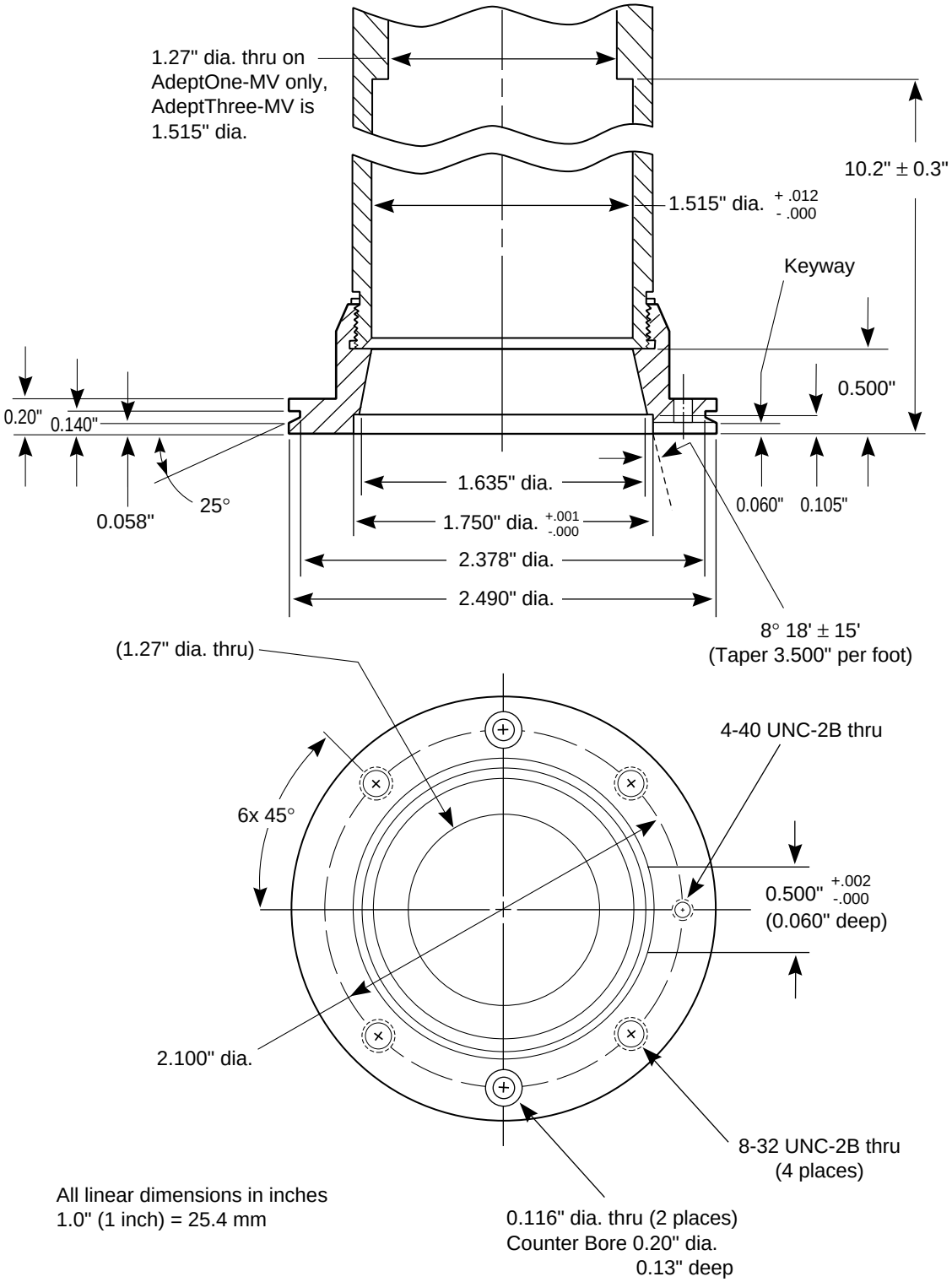



**Figure 6-5. User (Quill) Flange Dimensions for AdeptOne-MV and AdeptThree-MV Robots**

## User (Quill) Flange Dimensions for Adept PackOne Robot

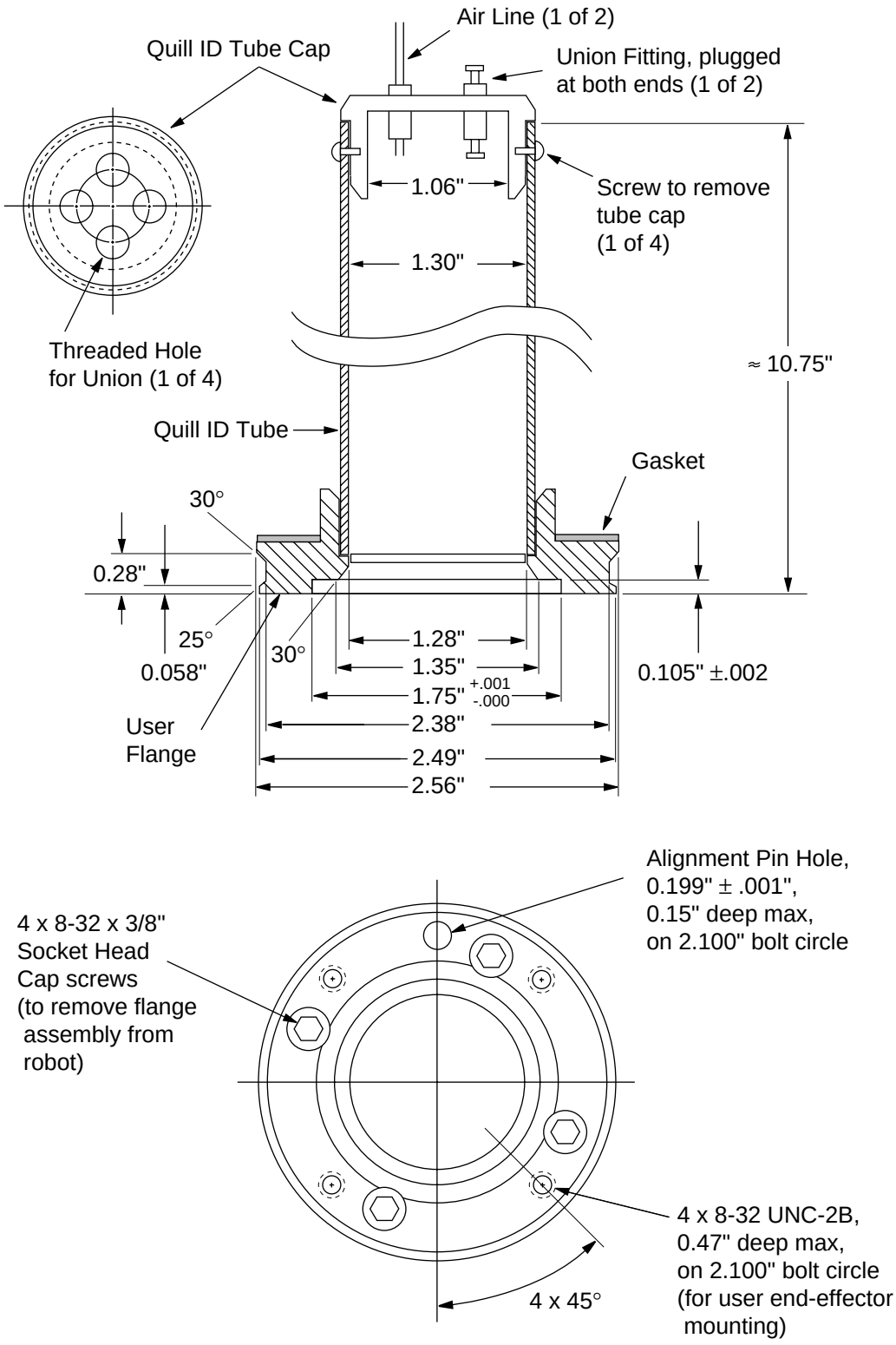



**Figure 6-6. User (Quill) Flange Dimensions for Adept PackOne Robot**

## Dimensions for Adept MV-8 Controller

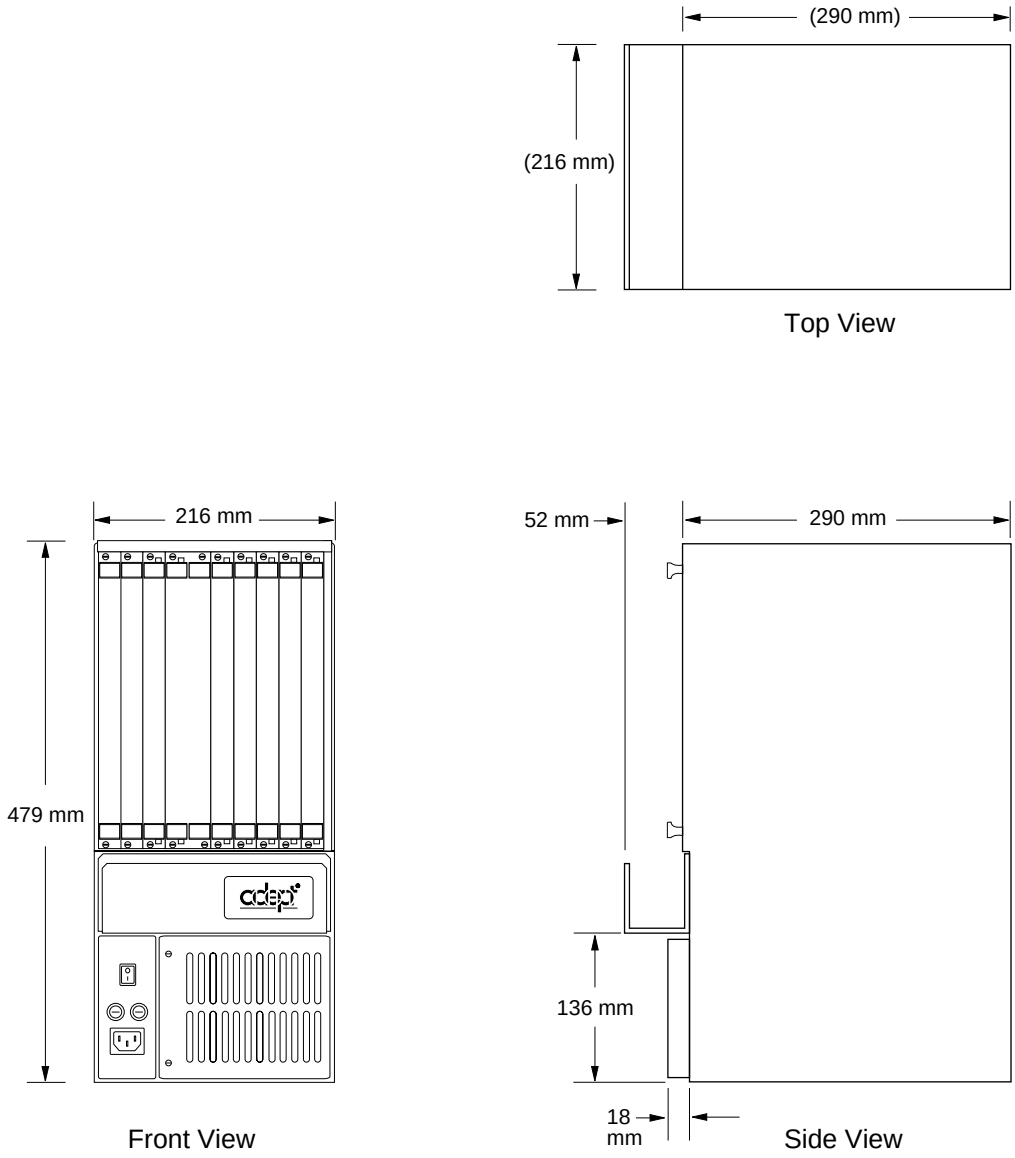



**Figure 6-7. Adept MV-8 Dimensions**

## Dimensions for Adept MV-19 Controller

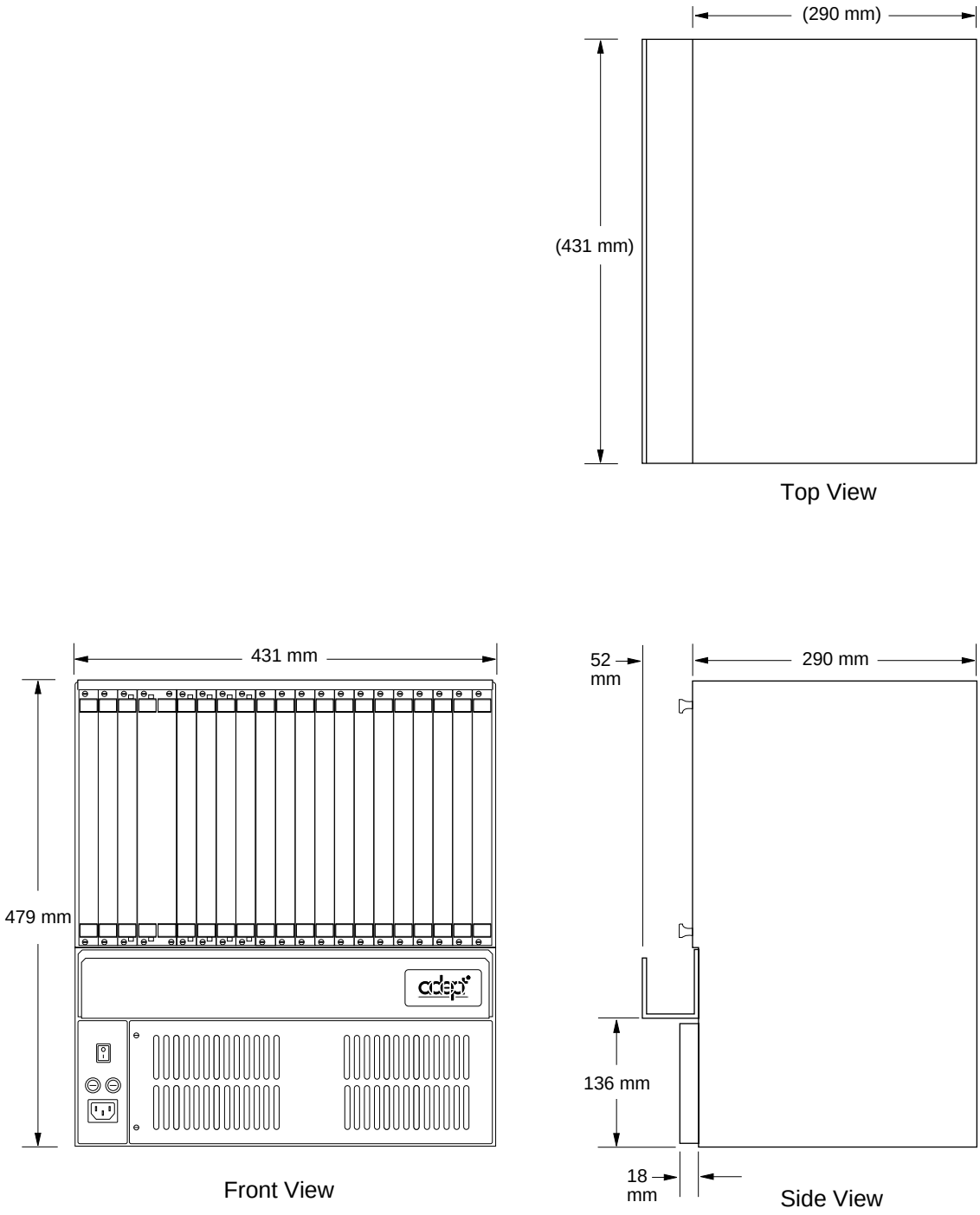



**Figure 6-8. Adept MV-19 Dimensions**

## Dimensions for Adept PA-4 Power Chassis

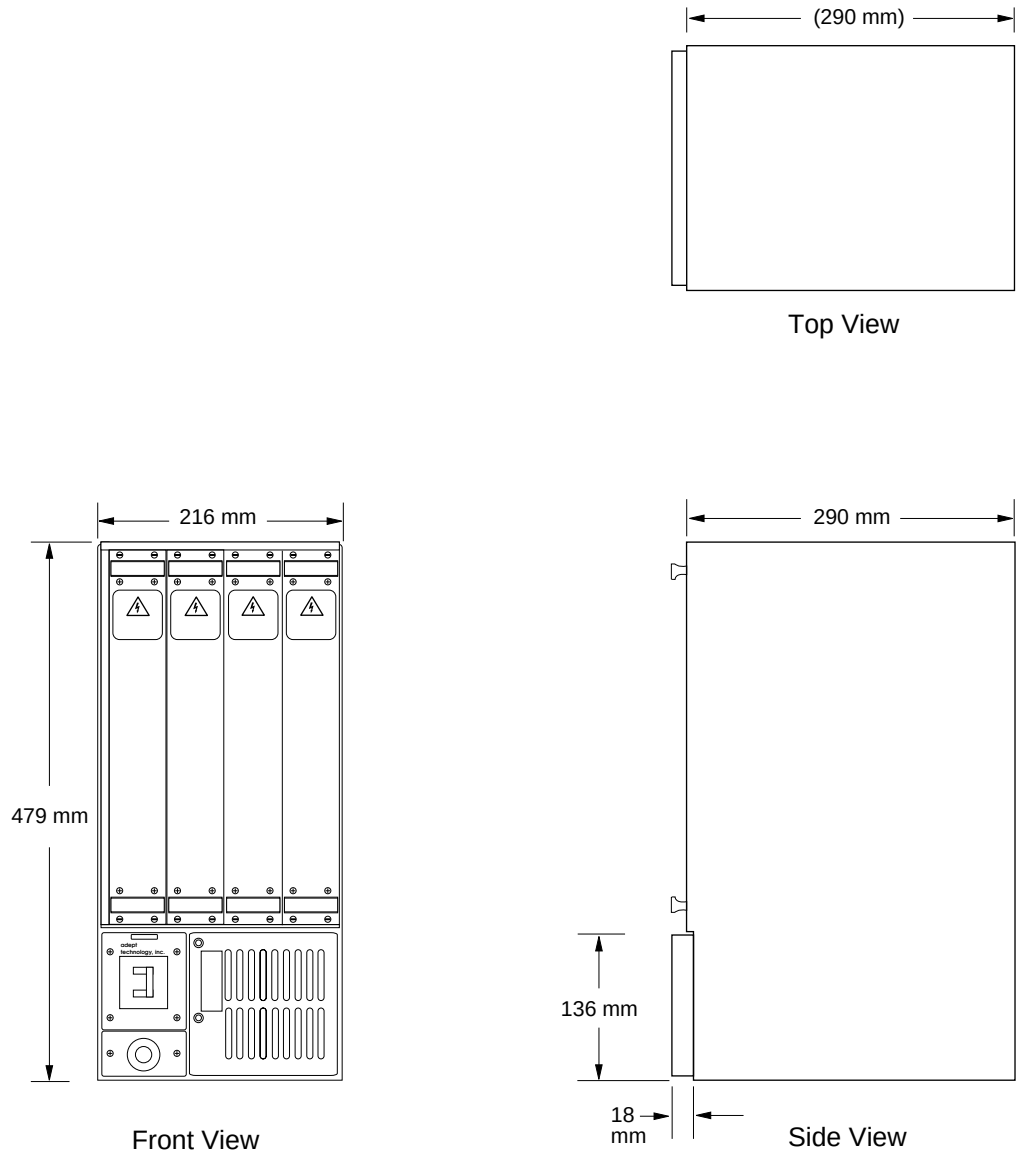



**Figure 6-9. Adept PA-4 Power Chassis Dimensions**

## Dimensions of the External Front Panel

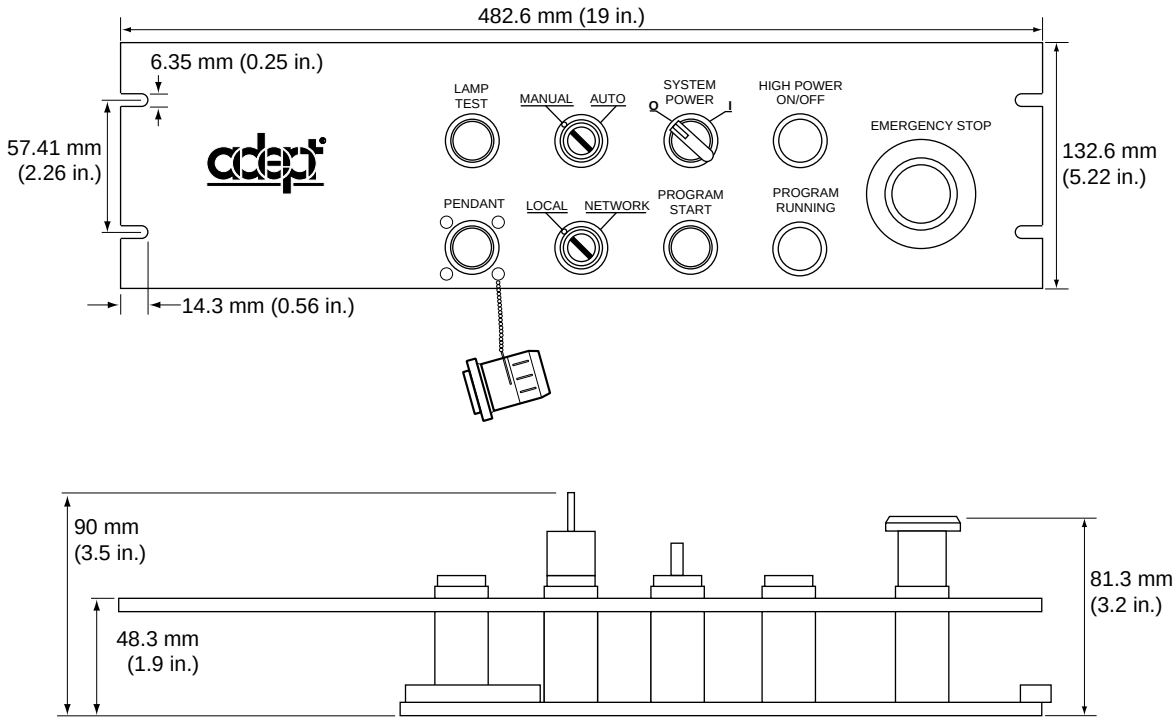



**Figure 6-10. Adept External Front Panel Dimensions**

## Dimensions of the Security Panel

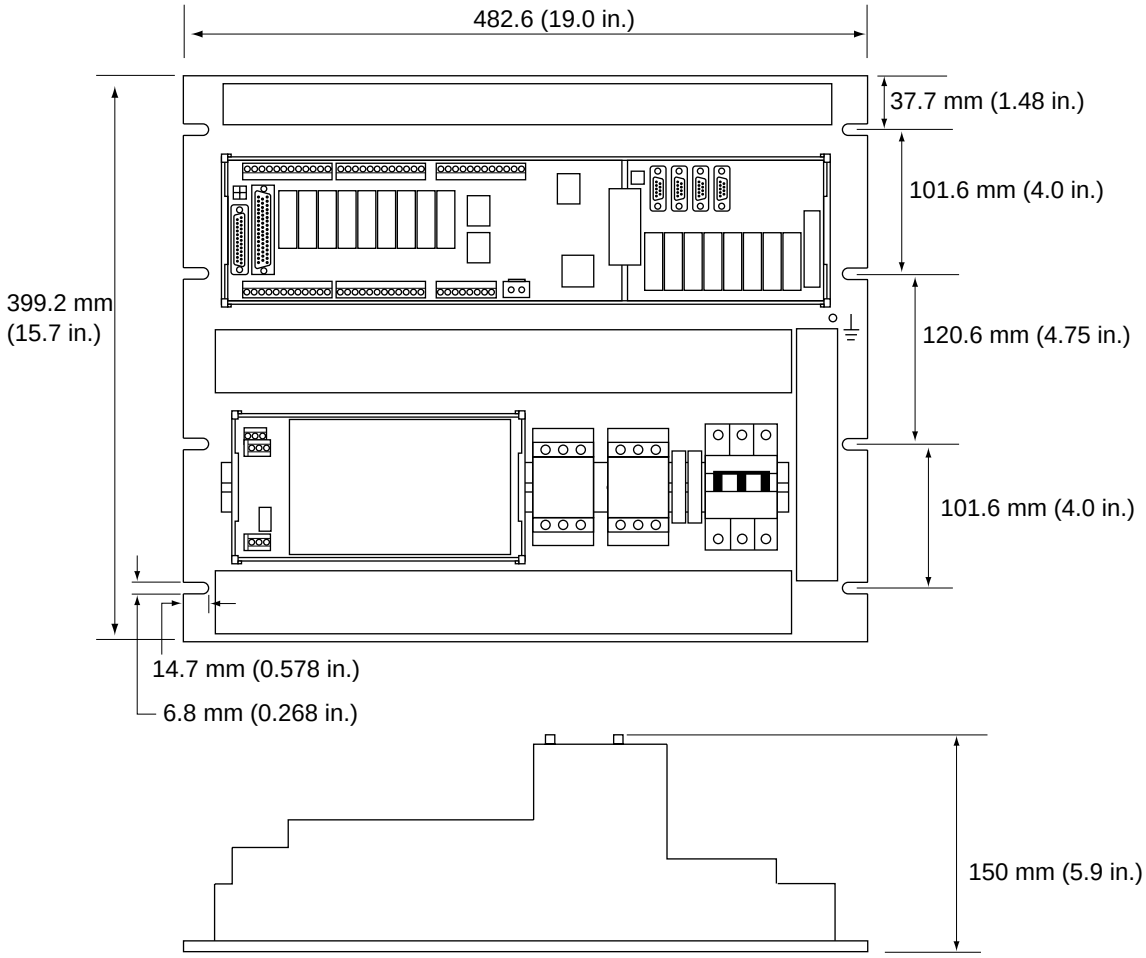
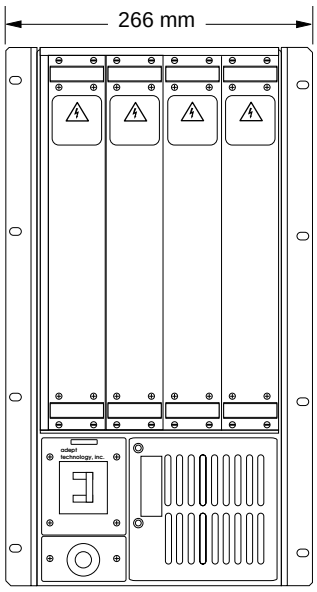
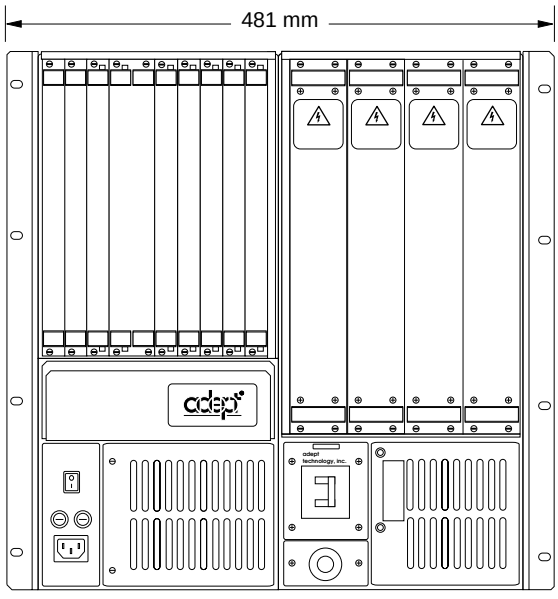



**Figure 6-11. Dimensions of the Security Panel**

## Dimensions of the Mounting Brackets




Power Chassis with mounting brackets installed




Controller and Power Chassis with mounting brackets installed

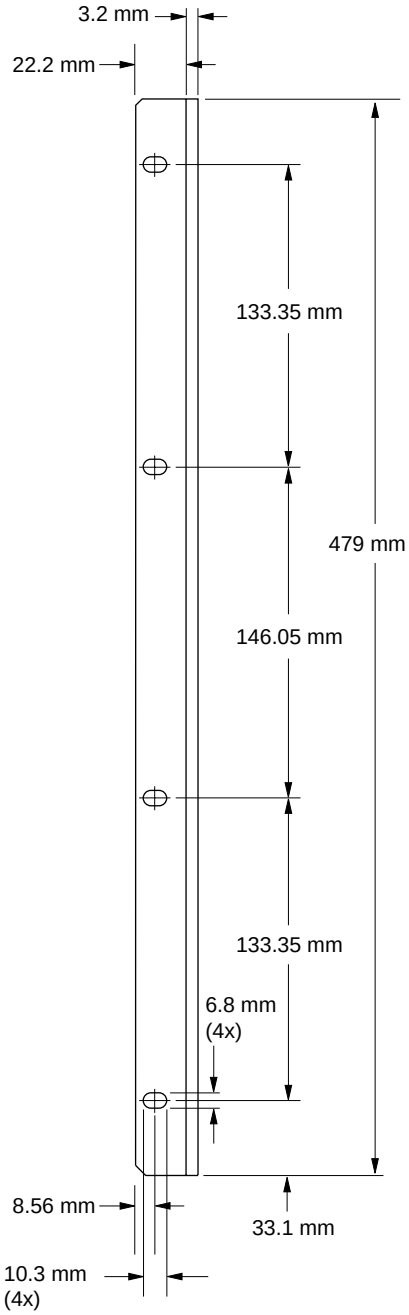



**Figure 6-12. Adept MV-8 and PA-4 With Mounting Brackets Installed**

## MCP Cradle Dimensions

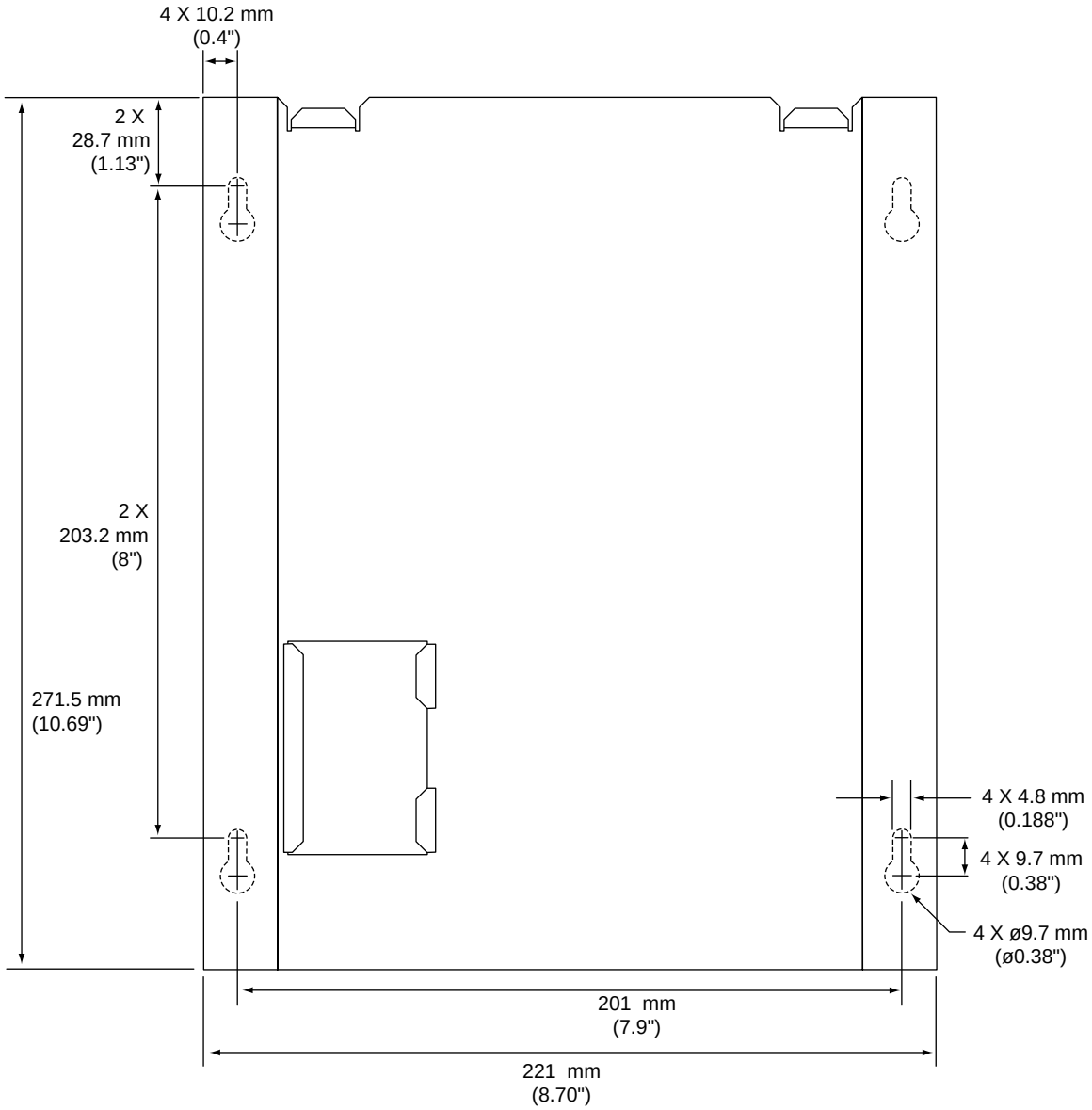



**Figure 6-13. MCP Cradle Dimensions**

## 6.2 Joint Motions

### Joint 1

Joint 1, also referred to as the shoulder, provides the rotational movement of the inner link and the column. Travel of the inner link is limited by software to 300°. (Refer to Figure 6-14.)

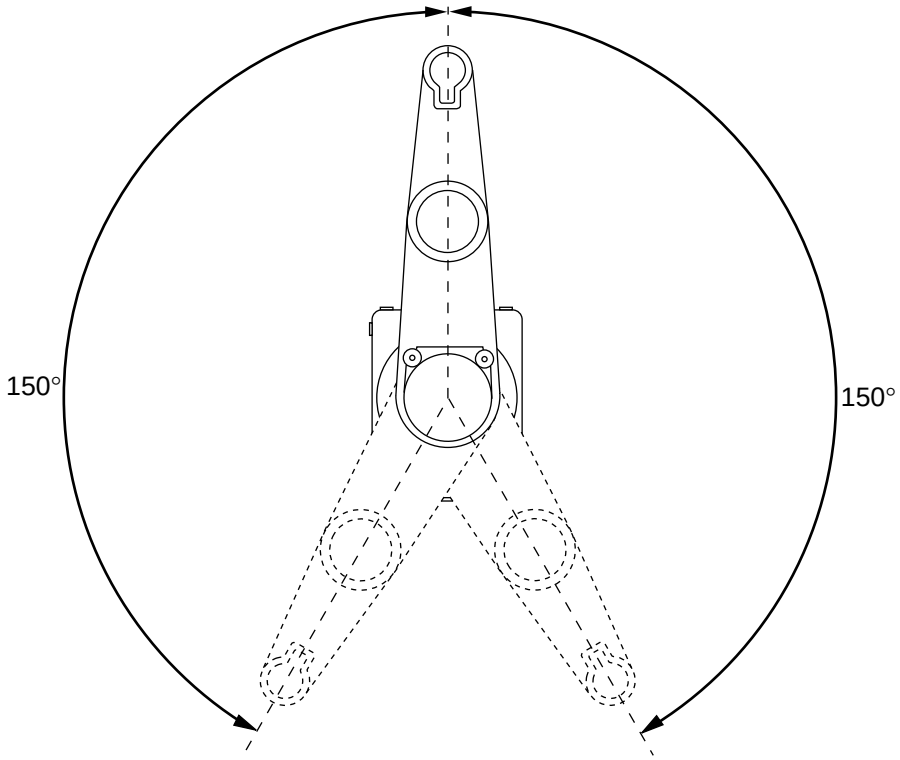



**Figure 6-14. Joint-1 Motion**

### Joint 2

Joint 2, also referred to as the elbow, is the pivot point between the inner link and the outer link. Outer link travel is limited by hardstops located on top of the inner link. Travel of Joint 2 is limited by software to the value set by the softstop. This motion can be likened to an elbow capable of acting in either a left- or right-hand configuration. (See Figure 6-15.)

The robot can reach a given location in either a right-hand (Righty) or left-hand (Lefty) configuration. However, when V+ moves the arm to a location, it must sometimes make assumptions about which configuration to use. While this generally produces the result desired by the programmer, sometimes the system assumption may differ from the programmer's expectations. In those cases, the programmer must specify (within the program) RIGHTY or LEFTY operation.

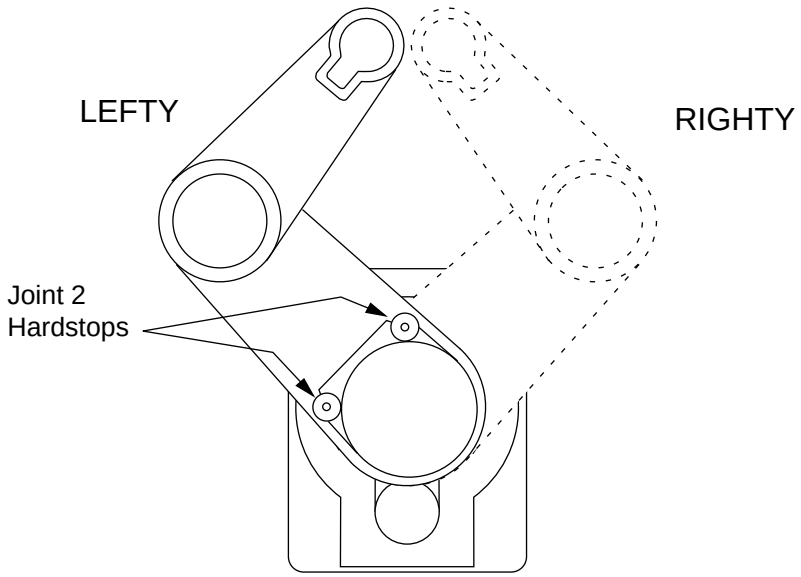



**Figure 6-15. Joint-2 Motion and LEFTY/RIGHTY Configurations**

## Joint 3

**AdeptOne-MV** and **Adept PackOne-MV** – Joint 3 provides vertical movement of the quill at the end of the outer link, with a standard stroke of 196 mm (7.7 inches). An extended-length version of the AdeptOne-MV and Adept PackOne-MV robot provides a Joint-3 stroke of 295 mm (11.6 inches). (Refer to Figure 6-16.)

**AdeptThree-MV** – The motion of Joint 3 on the AdeptThree-MV is the same as the AdeptOne-MV. There is only one stroke length; it is 305 mm (12.0″).

## Joint 4

Joint 4, also referred to as the wrist, provides rotation of the quill over a range defined by the softstop. This motion is similar to that of the human hand involved in tightening a bolt or unscrewing a bottle cap. (Refer to Figure 6-16.)

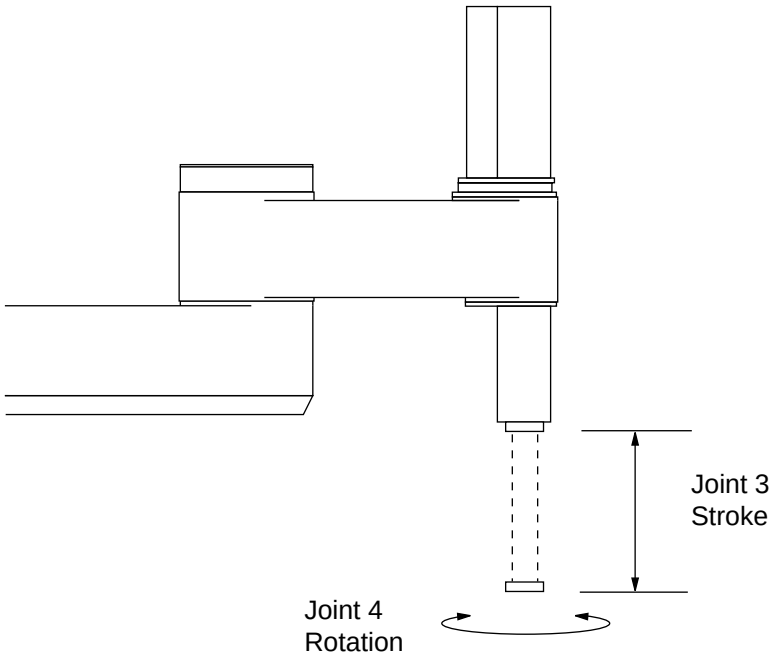



**Figure 6-16. Joint-3 and Joint-4 Motions**

## 6.3 AdeptOne-MV Robot Specifications

All specifications subject to change without notice.

**Table 6-1. AdeptOne-MV Robot Performance Specifications**

| | |
|---|---|
| **Reach** | |
| Maximum radial | 800 mm (31.5 in.) |
| Minimum radial | 231 mm (9.1 in.) |
| Vertical clearance (bottom of base to end-effector flange)<br>**Standard** 7.7 in. stroke<br>- with maximum Joint-3 retraction<br>- with maximum Joint-3 extension | <br><br><br>877 mm (34.52 in.)<br>679 mm (26.75 in.) |
| **Optional** 11.6 in. stroke<br>- with maximum Joint-3 retraction<br>- with maximum Joint-3 extension | <br>775 mm (30.52 in.)<br>480 mm (18.91 in.) |
| **Vertical Stroke** - Z direction | |
| **Standard** Joint 3 | 195 mm (7.7 in.) |
| **Optional** Joint 3 | 295 mm (11.6 in.) |
| **Joint Rotation** | |
| Joint 1 | 300° |
| Joint 2 | 294° |
| Joint 4 | 554° |
| **Payload** (Including End Effector) | 9.09 kg (20 lb) |
| **Inertia Load** (Maximum) | |
| About Joint-4 axis - standard | 281 kg-cm$^2$ (96 lb-in$^2$) |
| maximum[a] | 2926 kg-cm$^2$ (1000 lb-in$^2$) |
| **Force** | |
| Joint-3 downward force without payload | 18.2 kg (40 lb) |
| **Cycle Time – 12 in. (305 mm)**[b] | |
| No payload – standard<br>with HyperDrive | 0.70 sec<br>0.60 sec |
| 9 kg (20 lb) payload – standard<br>with HyperDrive | 0.92 sec<br>0.79 sec |
| **Resolution** | |
| Joint 1 | 0.00078° |
| Joint 2 | 0.00312° |
| Joint 3 (vertical Z) | 0.0033 mm (0.00013 in.) |
| Joint 4 (tool rotation) | 0.047° |

**Table 6-1. AdeptOne-MV Robot Performance Specifications (Continued)**

| | |
|---|---|
| **Repeatability** | |
| X,Y plane | ±0.025 mm (±0.001 in.) |
| Joint 3 (vertical Z) | ±0.050 mm (±0.002 in.) |
| Joint 4 (rotational) | ±0.05° |
| **Accuracy in X/Y Plane** (±3° F temperature variation) | |
| With optional HPS hardware and software, over 17" x 17" area | ±0.076 mm (±0.003 in.) |
| **Joint Speed** (maximum) | |
| Joint 1 | 540°/sec |
| Joint 2 | 540°/sec |
| Joint 3 | 500 mm/sec (19.7 in./sec) |
| Joint 4 | 3600°/sec |
| **Weight** | |
| Standard robot without options | 180 kg (400 lb) |
| Hyperdrive robot without options | 190 kg (418 lb) |
| Power chassis, with 3 amplifier modules | approximately 16.4 kg (36 lb) |
| MV-8 controller, with 030, SIO, VGB | approximately 14.5 kg (32 lb) |
| **Design Life** | 42,000 hours |

[a] Maximum possible using modified servo gains and running at reduced speed.
[b] The robot tool performs a continuous-path motion consisting of all straight-line segments; 25 mm (1 in.) up, 305 mm (12 in.) over, 25 mm (1 in.) down, and returning along the same path. The endpoints of the cycle are approached in COARSE mode.

## AdeptOne-MV Robot Working Envelope

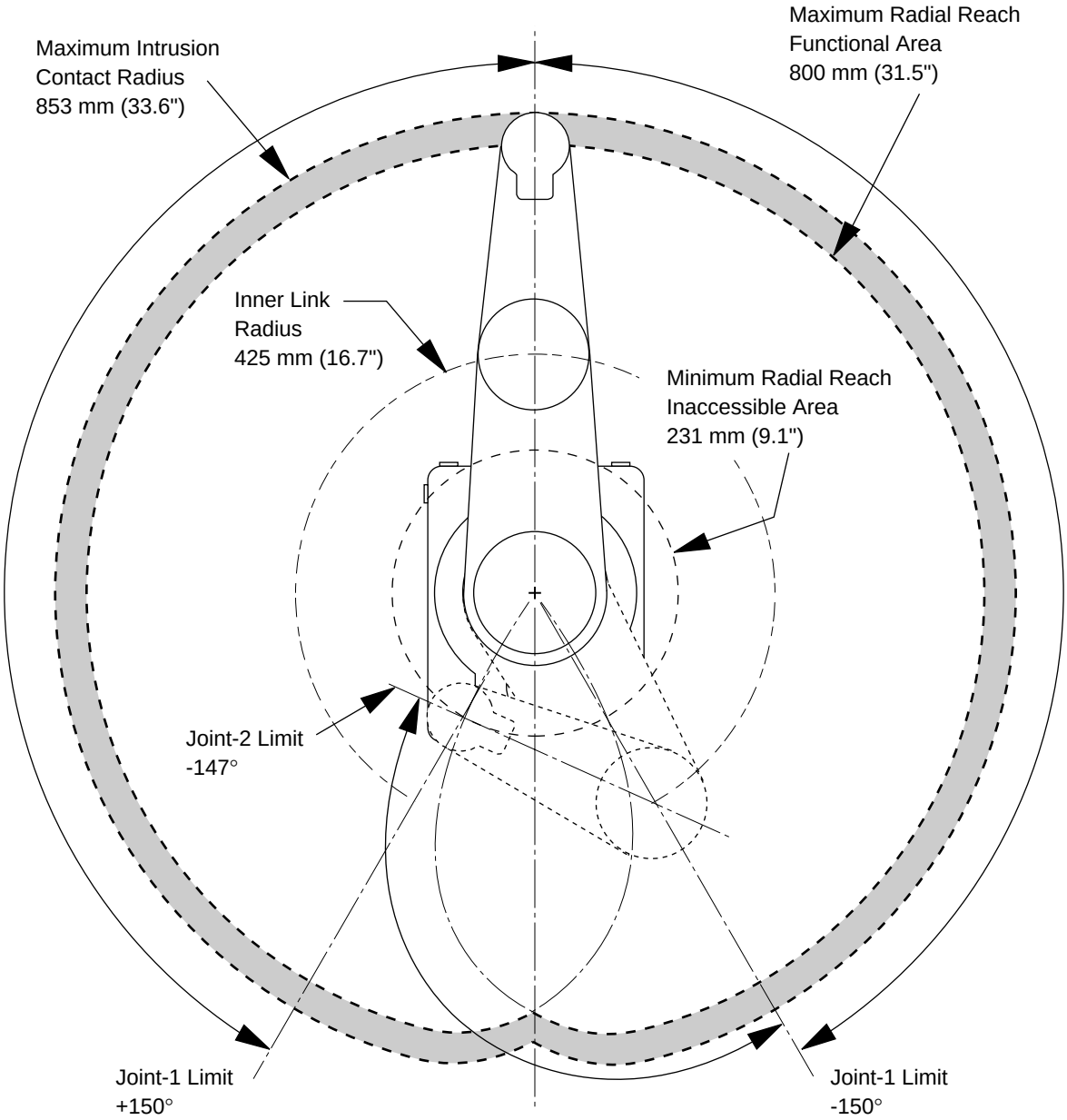



**Figure 6-17. AdeptOne-MV Robot Working Envelope**

## 6.4 AdeptThree-MV Robot Specifications

All specifications subject to change without notice.

**Table 6-2. AdeptThree-MV Robot Performance Specifications**

| | | |
|---|---|---|
| **Reach** | | |
| Maximum radial | | 1067 mm (42.0 in.) |
| Minimum radial | | 279 mm (11.0 in.) |
| Vertical clearance (bottom of base to end-effector flange)<br>- with maximum Joint-3 retraction<br>- with maximum Joint-3 extension | | <br><br>879 mm (34.6 in.)<br>547 mm (22.6 in.) |
| **Vertical Stroke** - Z direction | | |
| Joint 3 | | 305 mm (12.0 in.) |
| **Joint Rotation** | | |
| Joint 1 | | 300° |
| Joint 2 | | 300° |
| Joint 4 | | 540° |
| **Payload** (Including End Effector) | | 25 kg (55 lb) |
| **Inertia** | | |
| About Joint-4 axis - standard | | 585 kg-cm$^2$ (200 lb-in$^2$) |
| maximum[a] | | 7316 kg-cm$^2$ (2500 lb-in$^2$) |
| **Force** | | |
| Joint-3 downward force without payload | | 36.3 kg (80 lb) |
| **Cycle Time – 12 in. (305 mm)**[b] | | |
| No payload – | standard<br>with HyperDrive | 0.92 sec<br>0.83 sec |
| 9 kg (20 lb) payload – | standard<br>with HyperDrive | 1.08 sec<br>0.99 sec |
| **Resolution** | | |
| Joint 1 | | 0.00078° |
| Joint 2 | | 0.00312° |
| Joint 3 (vertical Z) | | 0.0066 mm (0.00026 in.) |
| Joint 4 (tool rotation) | | 0.047° |
| **Repeatability** | | |
| X,Y plane | | ±0.05 mm (±0.002 in.) |
| Joint 3 (vertical Z) | | ±0.05 mm (±0.002 in.) |
| Joint 4 (rotational) | | ±0.05° |

**Table 6-2. AdeptThree-MV Robot Performance Specifications (Continued)**

| | |
|---|---|
| **Accuracy in X/Y Plane** (±3° F temperature variation) | |
| With optional HPS hardware and software, over 17" x 17" area | ±0.076 mm (±0.003 in.) |
| **Joint Speed** (maximum) | |
| Joint 1 | 540°/sec |
| Joint 2 | 540°/sec |
| Joint 3 | 500 mm/sec (19.7 in./sec) |
| Joint 4 | 3600°/sec |
| **Weight** | |
| Robot without options | 205 kg (450 lb) |
| Hyperdrive robot without options | 213 kg (468 lb) |
| Power chassis, with 3 amplifier modules | approximately 16.4 kg (36 lb) |
| MV-8 controller, with 030, SIO, VGB | approximately 14.5 kg (32 lb) |
| **Design Life** | 42,000 hours |

[a] Maximum possible running at reduced speed.
[b] The robot tool performs a continuous-path motion consisting of all straight-line segments; 25 mm (1 in.) up, 305 mm (12 in.) over, 25 mm (1 in.) down, and returning along the same path. The endpoints of the cycle are approached in COARSE mode.

## AdeptThree-MV Robot Working Envelope

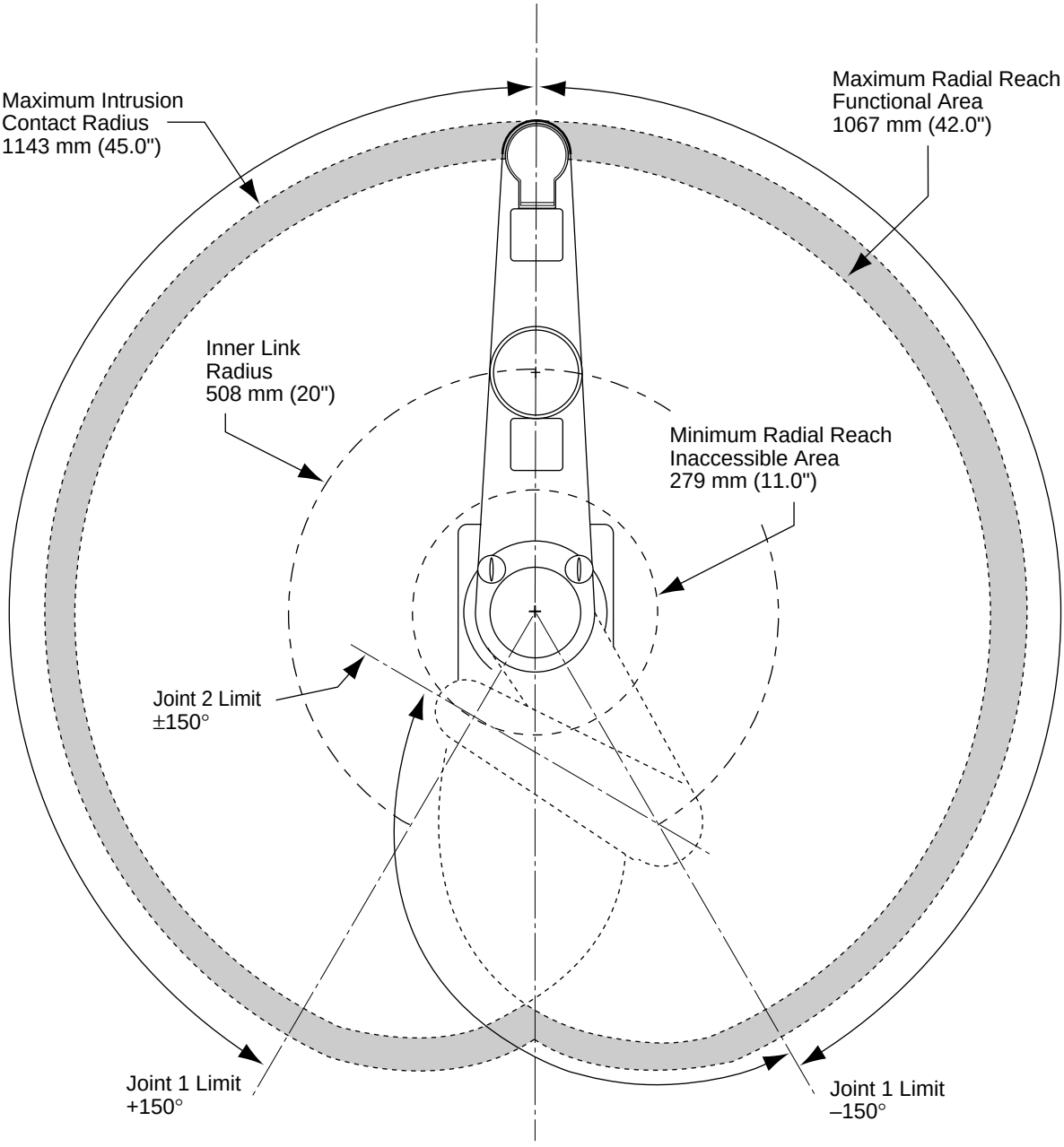



**Figure 6-18. AdeptThree-MV Robot Working Envelope**

## 6.5 Adept PackOne-MV Robot Specifications

All specifications subject to change without notice.

**Table 6-3. Adept PackOne-MV Robot Performance Specifications**

| | |
|---|---|
| **Reach** | |
| Maximum radial | 800 mm (31.5 in.) |
| Minimum radial | 245 mm (9.1 in.) |
| Vertical clearance (bottom of base to end-effector flange)<br>**Standard** 7.7 in. stroke<br>- with maximum Joint-3 retraction<br>- with maximum Joint-3 extension | <br><br><br>876 mm (34.5 in.)<br>681mm (26.8 in.) |
| **Optional** 11.6 in. stroke<br>- with maximum Joint-3 retraction<br>- with maximum Joint-3 extension | <br>775 mm (30.5 in.)<br>480 mm (18.91 in.) |
| **Vertical Stroke** - Z direction | |
| **Standard** Joint 3 | 195 mm (7.7 in.) |
| **Optional** Joint 3 | 295 mm (11.6 in.) |
| **Joint Rotation** | |
| Joint 1 | 300° |
| Joint 2 | 290° |
| Joint 4 | 540° |
| **Payload** (Including End Effector) | 7.7 kg (17 lb) |
| **Inertia Load** (Maximum) | |
| About Joint-4 axis - standard | 281 kg-cm$^2$ (96 lb-in$^2$) |
| maximum[a] | 2926 kg-cm$^2$ (1000 lb-in$^2$) |
| **Force** | |
| Joint-3 downward force without payload | 16.8 kg (37 lb) |
| **Cycle Time – 12 in. (305 mm)**[b] | |
| No payload – standard | 0.70 sec |
| 9 kg (20 lb) payload – standard<br>with HyperDrive | 0.92 sec<br>0.79 sec |
| **Resolution** | |
| Joint 1 | 0.00078° |
| Joint 2 | 0.00312° |
| Joint 3 (vertical Z) | 0.0033 mm (0.00013 in.) |
| Joint 4 (tool rotation) | 0.047° |

**Table 6-3. Adept PackOne-MV Robot Performance Specifications (Continued)**

| | |
|---|---|
| **Repeatability** | |
| X,Y plane | ±0.05 mm (±0.002 in.) |
| Joint 3 (vertical Z) | ±0.1 mm (±0.004 in.) |
| Joint 4 (rotational) | ±0.094° |
| **Accuracy in X/Y Plane** (±3° F temperature variation) | |
| With optional HPS hardware and software, over 17" x 17" area | ±0.076 mm (±0.003 in.) |
| **Joint Speed** (maximum) | |
| Joint 1 | 250°/sec |
| Joint 2 | 320°/sec |
| Joint 3 | 1000 mm/sec (39.4 in./sec) |
| Joint 4 | 3800°/sec |
| **Weight** | |
| Robot without options | 240 kg (525 lb) |
| Power chassis, with 3 amplifier modules | approximately 16.4 kg (36 lb) |
| MV-8 controller, with 030, SIO, VGB | approximately 14.5 kg (32 lb) |
| **Design Life** | 21,000 hours |

[a] Maximum possible using modified servo gains and running at reduced speed.
[b] The robot tool performs a continuous-path motion consisting of all straight-line segments; 25 mm (1 in.) up, 305 mm (12 in.) over, 25 mm (1 in.) down, and returning along the same path. The endpoints of the cycle are approached in COARSE mode.

## Adept PackOne-MV Robot Working Envelope

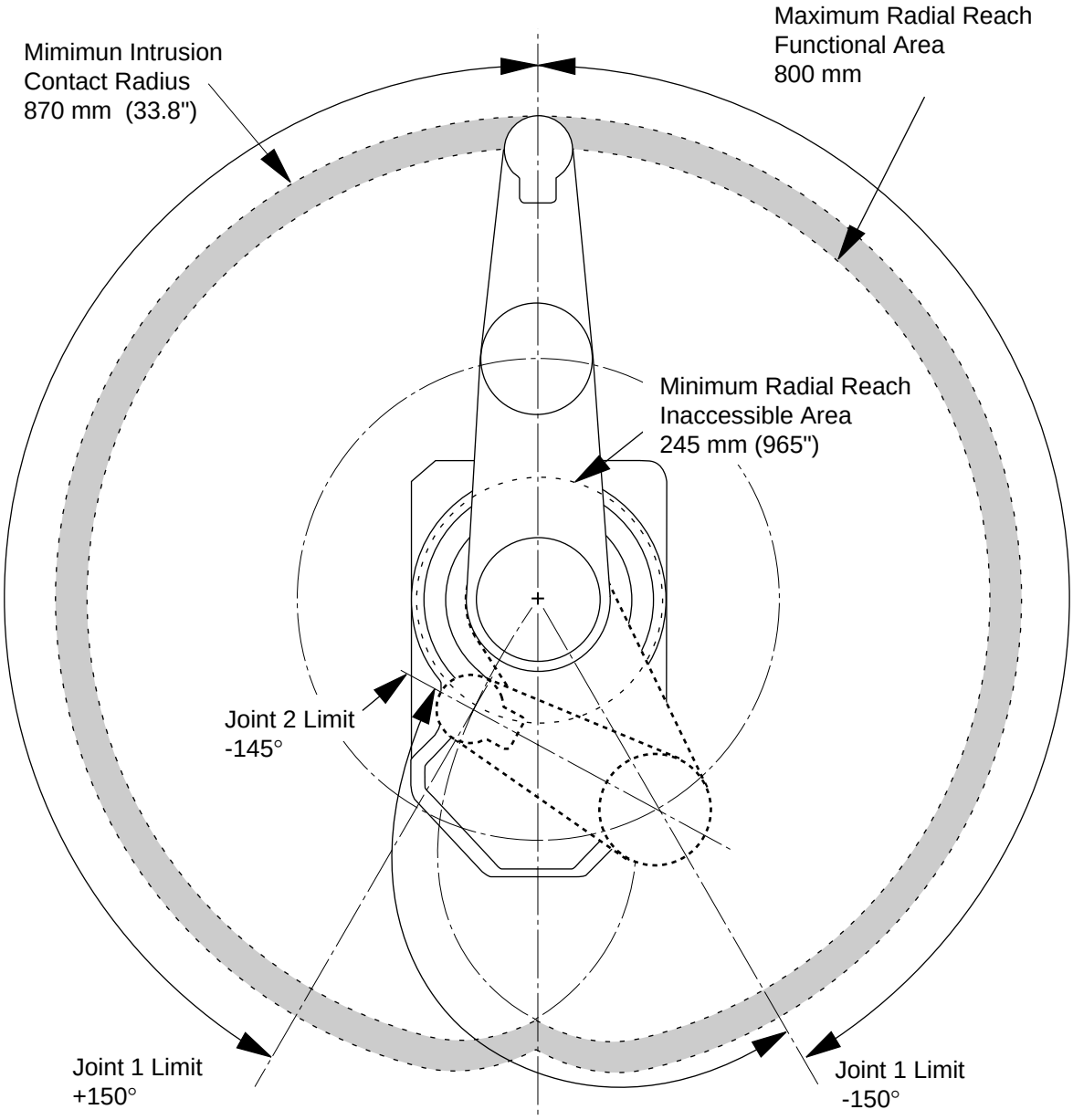



**Figure 6-19. Adept PackOne-MV Robot Working Envelope**

## 6.6 Adept PA-4 Power Chassis Specifications

The following power consumption information is provided to allow customers to install adequate electrical wiring and power sources for worst case (short duration) demands of the Adept PA-4 power chassis. The typical values are for calculating air conditioning requirements.

**Table 6-4. Power Consumption for PA-4 Power Chassis with an AdeptOne-MV System**

| Line Voltage | | Typical | Worst Case |
|---|---|---|---|
| 380-415 VAC, 50/60Hz, 3 phase[a] | Current (RMS) | 8.5 amps/phase | 20 amps/phase |
| | Watts | 1.65 kW | 3 kW |
| 200-240 VAC, 50/60Hz, 3 phase | Current (RMS) | 7.2 amps/phase | 17 amps/phase |
| | Watts | 1.65 kW | 3 kW |

[a] In the 380-415 VAC configuration, the Adept system draws current for a short duration during the positive peak voltage only.

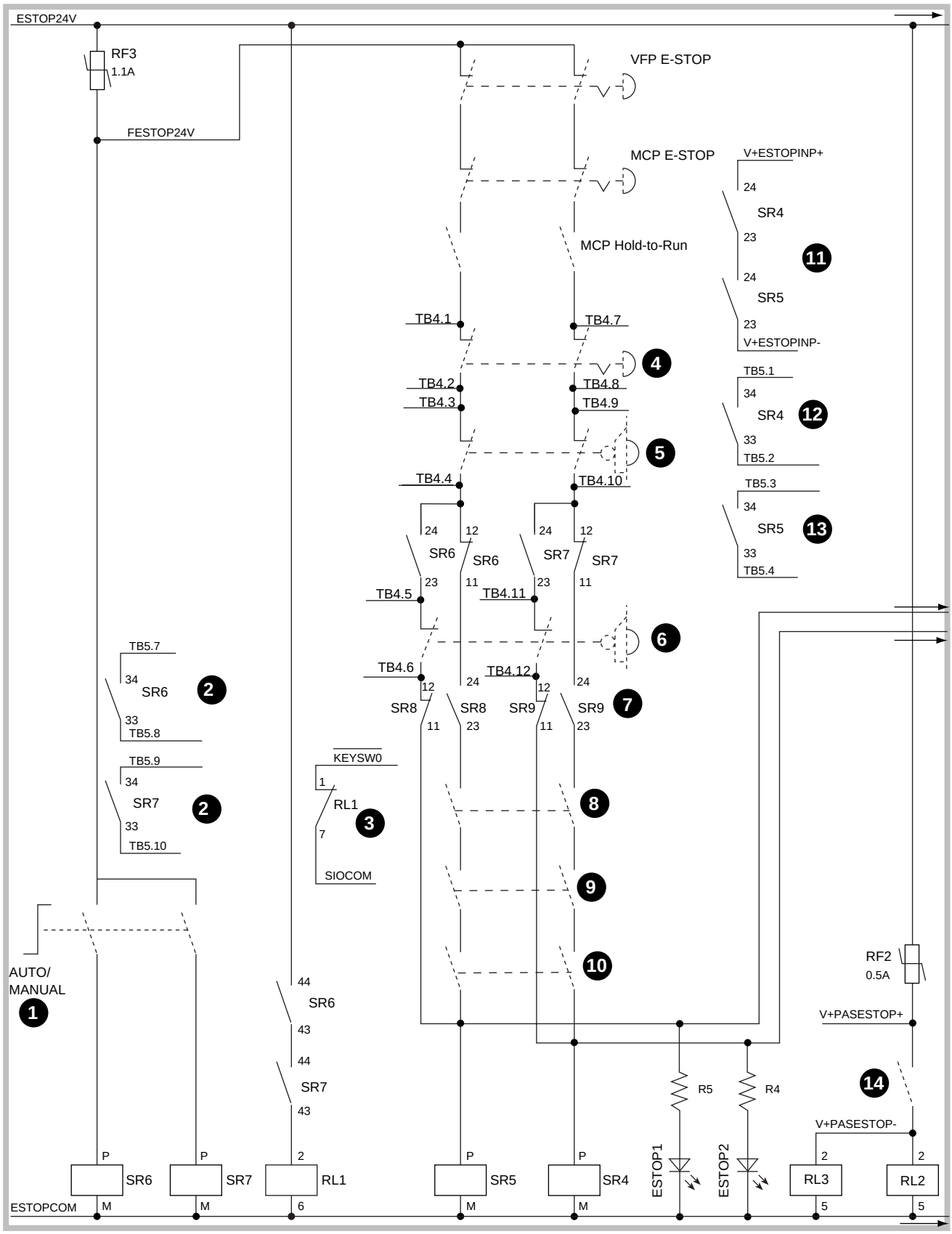
# Category 3 E-Stop Circuit A

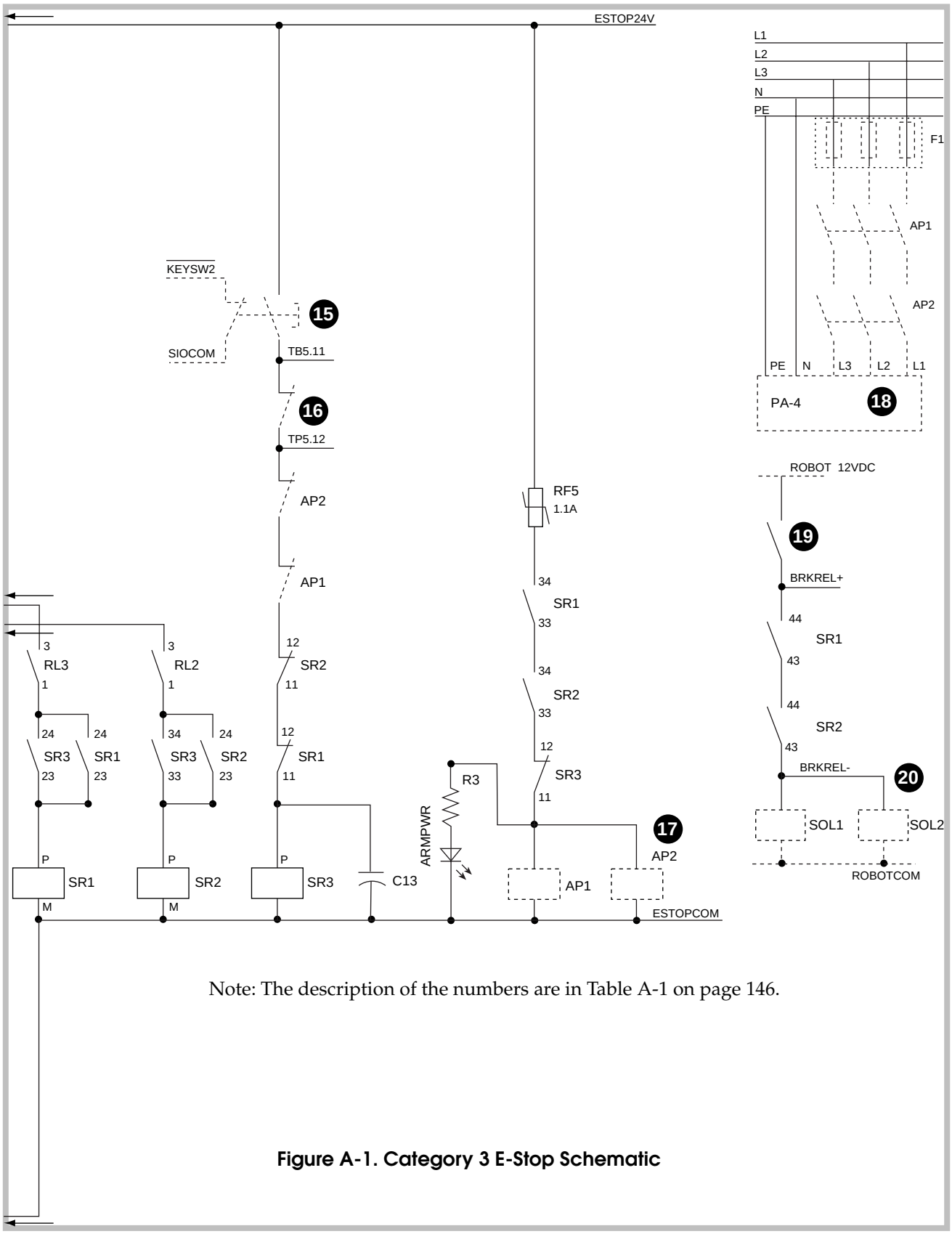
## A.1 Category 3 Emergency Stop Circuitry

The Category 3 Emergency Stop circuitry is mounted on the Security Panel. The components are on two DIN-rails, the Control Rail and the Power Rail.

The safety relay and power contactor diagram on the following two pages should help to understand the circuitry and to install the user-supplied parts of the Category 3 Emergency circuit.

> **NOTE:** For clarity, some components are omitted, such as current limiting resistors and inductive protection diodes.


ESTOP24V
RF3
1.1A
FESTOP24V
VFP E-STOP
MCP E-STOP
MCP Hold-to-Run
V+ESTOPINP+
V+ESTOPINP-
SR4
SR5
TB4.1
TB4.7
TB4.2
TB4.8
TB4.3
TB4.9
TB4.4
TB4.10
TB4.5
TB4.11
TB4.6
TB4.12
SR6
SR7
SR8
SR9
TB5.1
TB5.2
TB5.3
TB5.4
TB5.7
TB5.8
TB5.9
TB5.10
KEYSW0
RL1
SIOCOM
AUTO/
MANUAL
RF2
0.5A
V+PASESTOP+
V+PASESTOP-
R5
R4
ESTOP1
ESTOP2
RL2
RL3
ESTOPCOM
1
2
3
4
5
6
7
8
9
10
11
12
13
14




Note: The description of the numbers are in Table A-1 on page 146.

**Figure A-1. Category 3 E-Stop Schematic**

The following table gives the descriptions of the numbers in Figure A-1.

**Table A-1. Description of numbers in the Category 3 E-Stop Drawing**

| Nr. | Description of Numbers in the schematic |
|---|---|
| 1 | Front Panel MANUAL/AUTOMATIC<br>select key switch (MANUAL = Normally Open) |
| 2 | Customer Manual Mode #1 and #2 OUT, Voltage-Free Contacts |
| 3 | V+ Manual Mode Input Contacts |
| 4 | Customer E-Stop IN #1 and #2 Contacts |
| 5 | Customer Safety Barrier #1 and #2 Contacts |
| 6 | Customer Safety Barrier (Mute) #1 and #2 Contacts |
| 7 | Teach Restrict Cyclic Check Contacts |
| 8 | J1/J2 Accelerometer Contacts |
| 9 | J3 B-Amplifier: Speed Cutoff Contacts |
| 10 | J4 B-Amplifier: Speed Cutoff Contacts |
| 11 | V+ User External E-Stop Input Contacts |
| 12 | Customer E-Stop #1 OUT, Voltage-Free Contacts |
| 13 | Customer E-Stop #2 OUT, Voltage-Free Contacts |
| 14 | V+ High Power Enable (Passive E-Stop) |
| 15 | High Power On/Off Push-Button |
| 16 | Customer Safety Relay IN N/C Feedback Contacts |
| 17 | PA4-Power Amplifier Chassis Contactors |
| 18 | Power Chassis |
| 19 | Robot RSC Brake Release Enable Driver |
| 20 | Robot Brake Release Enable Solenoids |

# CleanRoom Option B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Vacuum Switch . . . . . 149

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Removing the Bellows . . . . . 150

Installing the New Bellows . . . . . 150

Further Instructions . . . . . 151

# B.1 Introduction

The CleanRoom option can be ordered with an AdeptOne-MV robot. During the manufacturing process the AdeptOne robot is modified to meet class 10 cleanroom specifications.

This package includes the following:

1. Integral seals on covers
2. Quill bellows
3. Vacuum fitting (1 1/4" male threaded)
4. Seals at Arm Signal and Arm Power Cable connectors

**NOTE:** Seals are present under the access covers, see Figure B-1. If removal of an access cover is necessary, the seal must be put back in place. The robot will not meet class 10 cleanroom specification unless all seals are in place, and proper vacuum is maintained.

# B.2 Installation

The CleanRoom option requires the use of a vacuum supply, provided by the customer. This section details the vacuum requirements of the systems, installation procedure, and tests to assure that the system is maintaining adequate vacuum levels.

## Vacuum Requirements

Negative air pressure applied to the inside of the robot creates flow from the outside to inside in two primary places, the gap between the inner and outer links, and the open bearing at the bottom of the quill. This type of system gives excellent cleanliness, but does not require high levels of vacuum.

The quill of the robot is covered by a polyurethane bellows. The bottom of the bellows is clamped to a bearing so that the bellows flexes only in the Z (up and down) direction. The vacuum system maintains enough air velocity and pressure differential so that no particles escape. Because the volume contained by the bellows changes when Joint 3 moves up and down, the system has been designed to accept this "pumped" air volume without allowing a positive pressure to develop across the bearing at the bottom of the quill.

The seal between the inner and outer links allows air to flow freely from the outside of the robot toward the negative pressure inside the robot, pulling any particles into the arm.

Vacuum requirements are defined in terms of a required level of vacuum at the base of the robot, and corresponding flow required to create this level of vacuum. These requirements are listed below:

- Minimum input vacuum: 20 inches of water column (W.C.)
- Maximum input vacuum: 30 inches of water column (W.C.)
- Minimum air flow: 25 SCFM

A practical requirement is that a minimum vacuum be maintained at the quill, even during the fastest possible motions of Joint 3 and 4. It is possible to adjust the amount of vacuum being applied to the system, provided the following minimum vacuum level is met when the robot is stationary.

- Minimum arm vacuum: 4.5 inches W.C. measured at the tool flange
- Maximum arm vacuum: 8.5 inches W.C. measured at the tool flange

These specifications result in sufficient vacuum to ensure that the installed, functioning robot will be clean, even at full speeds.

The plug covering the bottom of the tool flange has a 1/8 or 1/4 N.P.T. tapped hole to facilitate measuring the vacuum. Both of the above vacuum levels can be measured using a low pressure differential pressure meter.

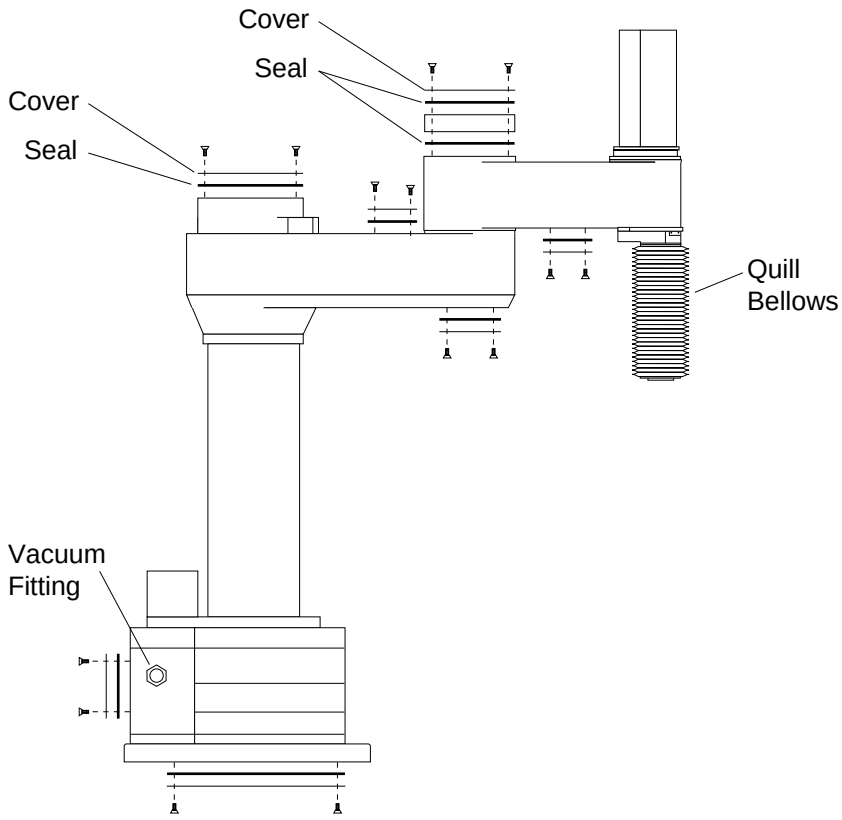


**Figure B-1. CleanRoom Features**

## Vacuum Installation

### Vacuum Supply Pump

In order to select a vacuum supply pump, the customer must evaluate the distance between to robot and vacuum pump, and pipe size.

### Pipe Size

The first topic in this section discusses rough rules of thumb to determine the pipe size required for an acceptable pressure drop. The second topic lists optional features of installed piping, and might be used as a check list by the installer.

Pipe sizes to be used when hooking up the robot to a vacuum source are a function of several factors:

- air flow requirements of the system
- distance from vacuum pump to robot
- vacuum pump used

All discussions assume the use of PVC pipe, due to its low cost, ease of installation, good flow characteristics, and availability.

The first consideration in pipe size is the location of the vacuum pump with respect to the robot. Given the location of the pump, a diagram displaying the pipe layout should be drawn. This allows the counting of fittings, and their conversion to equivalent pipe distances. Estimates of pipe fitting flows converted to straight pipe equivalents for three common pipe diameters are shown in Table B-1. These distances are then added to the nominal amount of straight pipe to create a total pipe length. There are practical limits to the length of pipe of a certain diameter.

The CleanRoom option provides a 1-1/4 inch male thread pipe fitting for the vacuum connection on the outside of the base of the robot, see Figure B-1. This can be adapted to any vacuum supply pipe being used. Adept recommends the connection include the following features:

- Union at the robot which allows the robot to be removed from the workcell.
- A tee with a threaded plug machined to accept a vacuum sensing switch. This allows the vacuum to be tested.
- A gate valve in line with the vacuum piping and located near the robot. This will allow regulation of the vacuum at the robot. Keep in mind that gate valves have flow losses 10 to 12 times lower than that of globe or ball valves.
- Union at the wall separating the vacuum pump and robot.
- Union at the vacuum pump which allows the pump to be replaced.

**Table B-1. Pipe fitting flow equivalents (in feet of straight pipe)**

| | Pipe Size | | |
|---|---|---|---|
| **Fitting** | **1-1/4 inch** | **1-1/2 inch** | **2 inch** |
| 90 degree | 7 feet | 8 feet | 10 feet |
| 45 degree | 1.5 feet | 1.8 feet | 2.3 feet |

#### Vacuum Switch

Maintaining adequate levels of vacuum is critical for cleanroom environments. The robot gives no external indication whether the vacuum is present or not. Adept suggests vacuum switches be used as a method of assuring proper vacuum is present.

Such a switch could provide contact closure while the vacuum is within the appropriate range. The switch can be used in series with any other external E- stop devices. This method will allow High Power to be turned on only if vacuum is present. The user would see an *External E-stop* error message on the system monitor/terminal, if the vacuum fails.

> **NOTE:** To comply with the requirement for redundant E-Stop loops, use two independent switches if an E-Stop is needed to sense the presence of a vacuum.

### Testing the Vacuum

Setting the vacuum switch requires that all parts of the robot and vacuum systems be installed. High Power need not be enabled, but the Arm Power and Arm Signal cables connecting the robot to the Adept MV Controller and Adept PA-4 Power Chassis must be connected, with their seals. Connect a vacuum gauge to the pipe tee just outside the robot's vacuum supply fitting. Turn the vacuum system on and wait a few moments for the system to stabilize. Adjust the vacuum to within the limits mentioned in "Vacuum Requirements" on page 148, plus roughly 1-1/2 inches W.C. of vacuum. Adjust the switch so that this is the vacuum falling setpoint. That is, set the switch for this point, apply for more vacuum, then gradually reduce the amount of vacuum until the switch trips. This helps compensate for switch hystereses. The extra 1-1/2 inches of vacuum allows for the normal swing of vacuum (roughly 1 inch) as Joint 3 is moved up and down. Reset the vacuum supply to the normal setting.

## B.3 Bellows Replacement

The quill bellows should be visually inspected for wear every month. Particular attention should be given to the area of the bellows in contact with the two clamps. If any signs of wear are visible, the bellows should be replaced.

The bellows should be replaced every three months. The procedure below outlines the replacement of the bellows.

### Required Materials and Tools

To perform this procedure you will need the following tools, parts and materials:

1. Replacement Bellows Kit (Adept part number 90842-99900) includes:
   a. One Bellows Cover (used for both 7.7 inch and 11.6 inch AdeptOne robots)
   b. One 3-1/2 inch bellows clamp (bottom)
   c. One 4-1/2 inch bellows clamp (top)
   d. Two 3/4" long #4-40 hex head screws (cap screws)

2. Hex Wrenches (3/32 inch and 7/64 inch)
3. X-acto knife

## Removing the Bellows

Move the robot to an area that will allow access to the outer link area and move Joint 3 midway between the hard stops. Disable High Power to the robot. Switch off the On/Off power switch on the Adept MV Controller and the Adept PA-4 Power Chassis.

Refer to Figure B-2 while performing this procedure. Loosen the top bellows clamp and slide it out of the way. Pull the top of the bellows away from the housing.

Screw the two 3/4 inch long 4-40 cap screws (provided) into the tapped holes in the perimeter of the bearing mounts. Remove the two 3/16 inch long 4-40 screws from the bottom of the quill flange. Using a 7/64 inch hex wrench, turn the set screws 2-3 turns counter-clockwise, or until the bearing mount begins to drop.

Remove the bearing mount from the robot, then remove the lower bellows clamp. Pull the bellows off the bearing.

## Installing the New Bellows

Place the smaller end of the bellows over the outer race of the bearing. Placing the bearing flat on a table should make the bellows cuff easier to slide over the bearing. Fit the cuff so that it is roughly 1/32 inch beyond the bearing, yet not so much as to contact the bearing mount. Keeping the bellows even with the bearings helps to extend its life. Clamp the bellows onto the bearing, keeping wrinkles to a minimum.

If the bellows cuff is pushed down against the bearing mount, it must be trimmed. This allows air flow through the bearing, and prevents rubbing. If the bellows cuff must be trimmed, use a new X-acto knife blade.

Push the two sliding pins in until their flat surface contacts the O-ring. The O-ring should be evenly seated around the groove, with the bellows on the top, slide the bearing mount over the robot's tool flange. Slide both of the mount pins in until its tip is aligned with the through hole in the robot's tool flange. Install one of the 3/16 inch long 4-40 screws into the bottom of the quill flange. Using a 7/64 inch hex wrench, tighten the set screws evenly from each side until they hold the bearing mount steady.

Place the top bellows clamp loosely around the top cuff of the bellows. Putting your fingers between the first and second of the top convolutions, push the top bellows cuff up and around the clamping diameter of the vacuum housing. It must wrap smoothly around the diameter. Tighten the clamp around the bellows cuff, trying to minimize wrinkles. The bellows cuff must be pushed up enough so that the clamp has full contact with the bellows cuff. Mounting the bellows so that the top convolution is parallel with the bottom of the vacuum housing will help to extend the life of the bellows.

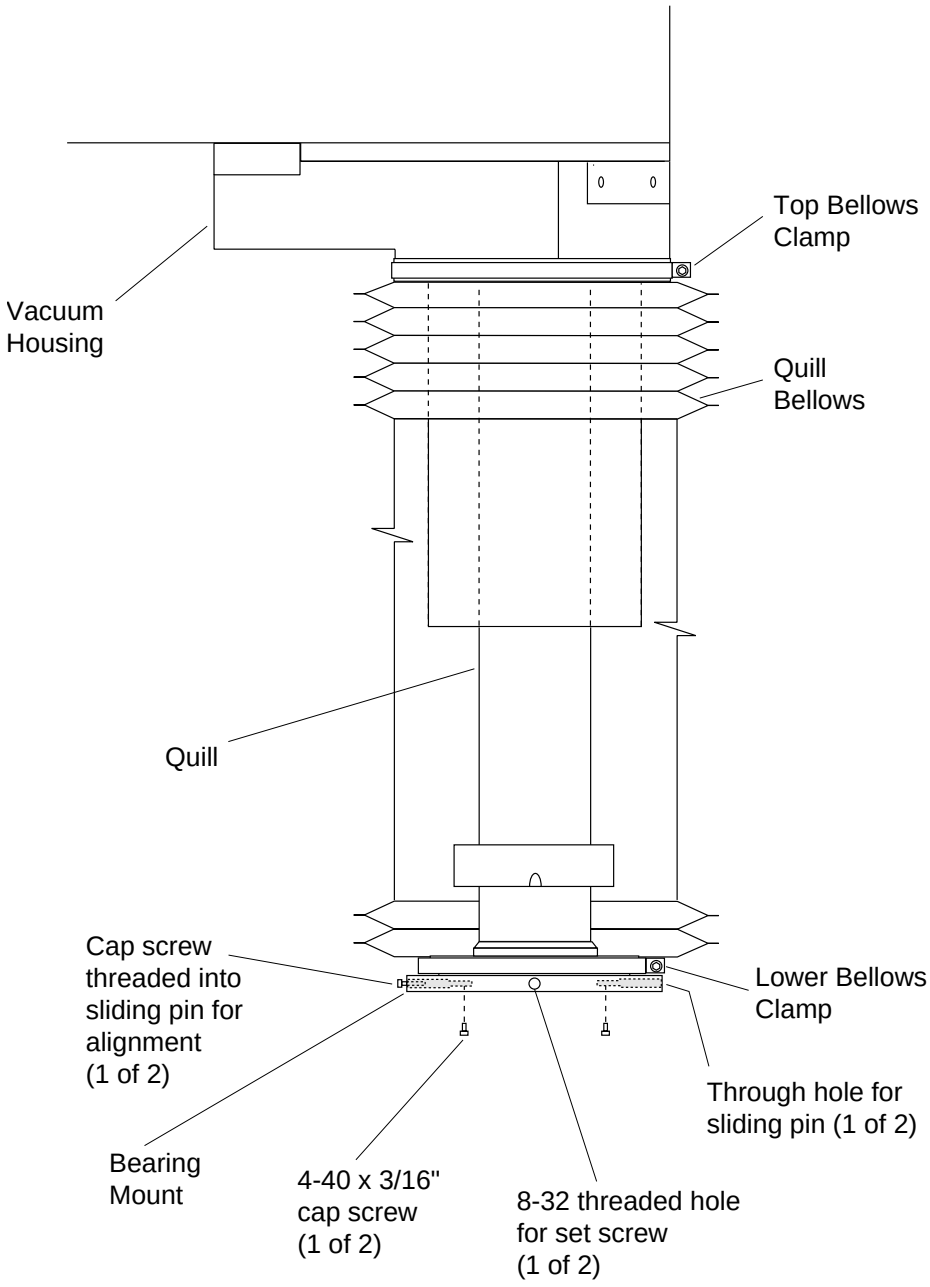
Top Bellows Clamp
Vacuum Housing
Quill Bellows
Quill
Cap screw threaded into sliding pin for alignment (1 of 2)
Lower Bellows Clamp
Through hole for sliding pin (1 of 2)
Bearing Mount
4-40 x 3/16" cap screw (1 of 2)
8-32 threaded hole for set screw (1 of 2)

**Figure B-2. Bellows Detail**

## Further Instructions

The vacuum must now be tested, refer to "Testing the Vacuum" on page 151. If the vacuum test fails, check the bellows for leaks and correct them if found.

After the vacuum has been tested, the end-of-arm tooling can be put back in place and the robot can be returned to normal use.

# Using the Safety Utility

C


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# C.1 Introduction

With a Category 3 system several components are in place to ensure safety when the robot is operating in the Manual mode. It is required that some components be tested at the time of commissioning, see Chapter 4. These components should also be tested periodically, every six months.

Adept provides SAFE_UTL.V2 to test these components. This section offers instructions for using SAFE_UTL.V2 and describes the tests required to commission the robot. Additional tests should be performed periodically. These tests are also described in this section.

## Category 3 Robot Components

### Accelerometer

An accelerometer is located in the outer link of the robot to prevent excessive acceleration of Joints 1 and 2 while operating in Manual mode. If the accelerometer is tripped, the emergency stop circuit is opened, causing High Power to be disabled.

### B+ Amplifier Voltage Restrict

Circuitry in the B+ amplifier measures the voltage applied to the Joint 3 and 4 motors. This will prevent excessive speed, and acceleration, while operating in manual mode. If the voltage exceeds a preset limit, the emergency stop circuit is opened, causing High Power to be disabled.

### VFP Switches and Buttons

After the user requests High Power to be enabled, the HIGH POWER lamp flashes. Before High Power is turned on, this button must be pressed. If the button is not pressed within 10 seconds[1], it will stop flashing and High Power will not be turned on. Tests are also performed on the LAMP TEST button, PROGRAM START button and the key switches.

### MCP Hold-To-Run Switch

The Hold-To-Run switch on the Manual Control Pendant must be pressed for High Power to remain on. If the Hold-To-Run switch is released for any reason, High Power is disabled. If the MANUAL/AUTO key switch is in the manual position, the Hold-To-Run switch must be cycled when the user requests High Power to be enabled. This is to confirm, before enabling High Power, that the Hold-To-Run switch is operational. The following instructions are displayed on the screen and must be followed.

```
Release then press the Hold-To-Run button.
Press the HIGH POWER button when it blinks.
```

The Manual Control Pendant displays the following messages:

[1] The time out value can be changed using the CONFIG_C.V2 utility.

```
Release then press the Hold-To-Run button.
Press the HIGH POWER button to enable power.
```

The Hold-To-Run switch must be released, then pressed. The system will then attempt to turn on High Power, flashing the HIGH POWER lamp. The HIGH POWER button must be pressed and High Power will switch on.

The above procedure must be performed several times while running SAFE_UTL.

#### Dual Brake Solenoid Valves

Two brake solenoids are used to release the robot brakes. If one solenoid fails by sticking open, the brakes will still engage. If one solenoid fails by sticking closed, the brakes cannot be released. These components were tested at the factory, therefore, it is not required that they be tested at the time of commissioning. Both solenoid valves, however, must be tested periodically thereafter. See “Tests Performed Periodically” on page 168.

#### Dual Dump Valves (AdeptThree-MV Only)

Two dump valves are used on the AdeptThree-MV robot. Both dump valves open when the brake solenoids are closed, allowing the brakes to engage rapidly. If one dump valve fails by sticking closed, the other valve will open allowing the brakes to still engage rapidly. These components were tested at the factory, therefore, it is not required that they be tested at the time of commissioning. Both dump valves, however, must be tested periodically thereafter. See “Tests Performed Periodically” on page 168.

#### Robot Brakes

Brakes are in place to prevent robot motion when High Power is off, and to stop the robot during an Emergency-Stop. The brakes can be manually released by pressing the brake release button at the base of the robot. Brakes are used on Joints 1, 2 and 3. The AdeptThree-MV robot has an additional brake for Joint 4.

## C.2 SAFE_UTL.V2

Adept provides SAFE_UTL.V2 in the \UTIL\ sub-directory on the controller’s hard disk (drive C). This utility must be used to test the Category 3 robot components during the commissioning procedure. It is also used to test the components periodically.

### Commissioned vs. Not Commissioned

As shipped from Adept the system is marked as ’not commissioned’, meaning the Category 3 components must be tested prior to system operation. The brake solenoids and dump valves have been tested at the factory. Prior to operating the robot in the manual mode, the system must be marked as ’commissioned’. The system is marked as ’commissioned’ only after the SAFE_UTL.V2 utility is executed and all tests pass.

If any of the tests fail, carefully note any the messages then repeat the test. If the failure persists, contact Adept Customer Service.

The components should also be tested periodically, every six months. When the SAFE_UTL.V2 utility is started, the system is marked as ’not commissioned’. In order for the system to be marked as ’commissioned’ all components must pass the tests.

**NOTE:** Testing all Category 3 components requires approximately 40 minutes.

If an attempt is made to enable High Power (on a system marked as 'not commissioned') while the MANUAL/AUTO key switch is in the manual position, the following error message is displayed:

```
*User has not tested Cat 3 system*
*Switch can't be enabled*
```

## Starting the SAFE_UTL.V2 Utility

To perform the necessary tests, SAFE_UTL.V2 must be run. Follow the steps below to load and execute the program:

1. Remove all end-effectors from the quill flange.
2. Enable High Power and calibrate the robot. See section 4.7 on page 92.
3. Load the utility program into system memory with the command:

```
LOAD C:\UTIL\SAFE_UTL.V2
```

4. Start execution of the program with the command:

```
EXECUTE 1 a.safe_utl
```

The following menu is displayed:

```
*** Adept CE Category 3 Test Program (Version 11.3B) ***
      Copyright (c) 1996 by Adept Technology, Inc.

                  Robot 1: xxx-xxxx

                 Language Selection

                   0 => English
                   1 => Deutsch

                  Enter Selection:
```

The appropriate language selection can be made from this menu. The following is displayed:

```
WARNING: The current robot will be marked as 'not
commissioned', and will be marked as 'commissioned' only
after passing 'all tests'.

Do you want to continue (Y/N)?
```

If the system has previously been 'commissioned', responding Y marks the system as 'not commissioned'. The robot cannot be operated in the manual mode until all tests are completed and passed.

If the response is N, the system is left unchanged and the program halts.

**WARNING:** These tests must only be performed by skilled or instructed persons.

## C.3 Tests Performed at Time of Commissioning

**NOTE:** The screen displays and menus shown in sections C.3 and C.4 are presented to help you understand how the SAFE_UTL program works. We do not attempt to show all of the messages that actually occur when using the program.

The utility program displays the following menu and prompts the user to select an option.

```
*** Adept CE Category 3 Test Program (Version 11.3) ***
     Copyright (c) 1996 by Adept Technology, Inc.

        Robot 1: xxx-xxxx   *Not Commissioned*

             0 => EXIT
             1 => All Tests
             2 => Accelerometer
             3 => B+ Amp Voltage Restrict
             4 => VFP Switches and Buttons
             5 => MCP E-STOP Functions
             6 => Brake Holding Force


           Enter Selection:
```

In order for the robot to be marked as 'commissioned' option 1 must be selected. It is, however, strongly recommended that the individual options be tested first, starting with option 2. This will allow the user to become familiar with the tests and procedures before attempting to commission the robot. The other options can also be selected individually to test a component that has failed a test. After testing the individual component, option 1 must be selected again. The system is marked 'commissioned' only after all tests pass.

In some tests the system recognizes the result of the test on its own. Other tests require the operator to type a N or Y to indicate the result of the test. N indicates no, while Y indicates yes.

## Accelerometer Test

**WARNING:** The user must remain outside the robot workcell with all safety barriers closed while conducting these tests. Failure to observe this warning could cause serious injury.

The accelerometer is tested to ensure that it is operational. The following message is displayed:

```
Accelerometer test:
MCP controlled move, no E-STOP expected.
```

The MANUAL/AUTO and LOCAL/NETWORK key switches are checked by SAFE_UTL.V2. If a switch is in the improper position the following message is displayed:

```
Switch the MANUAL/AUTO keyswitch to MANUAL and
LOCAL/NETWORK keyswitch to LOCAL.
```

When the key switches are in the proper position High Power will be enabled displaying a request to cycle the Hold-To-Run button. See “MCP E-STOP Functions” on page 165. If you are not familiar with operating the MCP, review section 4.9 Moving the Robot with the MCP. When High Power is enabled the following message is displayed:

```
Use the MCP to drive Joint 1 at top speed.
Do NOT drive the robot onto a soft stop.

Press REC/DONE on the MCP when done.

If an E-STOP or other error occurs, press CLR ERR button
until REC/DONE flashes, then press REC/DONE.
```

Press the COMP/PWR button, then the REC/DONE button when motion is completed. During this test, the accelerometer should not be tripped. If there is a fault, make careful note of the error message and try again. If the error occurs a second time, contact Adept Customer Service. If no error occurs, the following is then displayed:

```
Program controlled move, expect E-Stop assert.
The default test locations are with Joint 1 at +/– 30
degrees from midrange and all other joints at midrange.
Do you want to use the default test locations (Y/N)?
```

**WARNING:** Responding Y causes the robot to move Joint 1 to the positions shown in Figure C-1. If the robot is in its workcell, it may contact other tooling and/or fixtures, causing extensive damage.

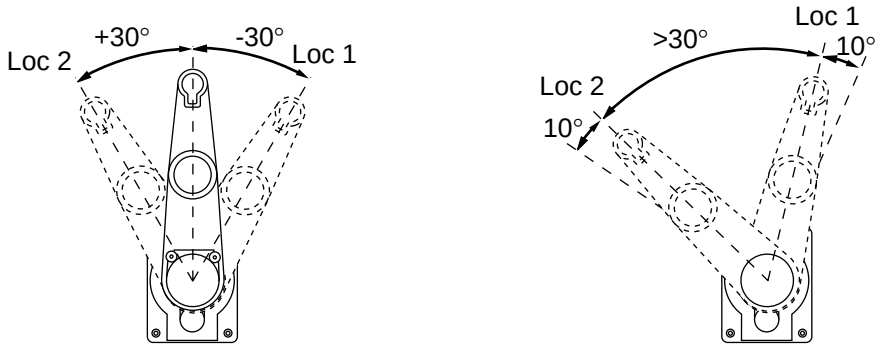


**Figure C-1. Test Locations**

Responding N allows new test locations to be defined. The test locations must be defined so that Joint 1 is driven at least 30 degrees, see Figure C-1. The robot will make a quick move, causing the accelerometer to activate the E-STOP. The robot may overshoot slightly. To ensure the robot does not crash, it should be able to move 10 degrees beyond the defined locations, in both directions. After the new test locations are defined, the following is displayed:

```
Testing Joint 1

Press the COMP/PWR button.
Hold the SPEED BAR then press and release the STEP button.
While continuing to hold the SPEED BAR, press and release
the STEP button.
The accelerometer has tripped as expected.
```

The MCP controlled move is repeated. If the test passes, the following is displayed:

```
Accelerometer test passes.

Press ENTER to continue.
```

Pressing ENTER will either begin the next test to be performed, or display the main menu. If the test fails, the main menu is displayed.

## B+ Amp Voltage Restrict Test

**WARNING:** The user must remain outside the robot workcell with all safety barriers closed while conducting these tests. Failure to observe this warning could cause serious injury.

As this test is started High Power must be enabled as described in the previous test. The voltage restrict circuitry is tested to ensure that it is operational. The following messages are displayed, as the program sequence progresses:

```
B+ Amp Voltage Restrict test, Joint 3:
MCP controlled move, no E-STOP expected.
Release then press the Hold-To-Run button.
Press the HIGH POWER button when it blinks.

Use the MCP to drive Joint 3 back and forth at top speed.
Do NOT drive the robot onto a soft stop.

Press REC/DONE on the MCP when done.

If an error occurs, press CLR ERR button until REC/DONE
flashes.
```

Press the COMP/PWR button, then the REC/DONE button when motion is completed. The voltage restrict circuitry should not fault out while performing this test. The following will then be displayed:

```
Program controlled move, expect E-Stop assert.
The default test locations are with Joint 3 at +/– 50 mm
from midrange and all other joints at midrange.
Do you want to use the default test locations (Y/N)?
```

**WARNING:** Responding Y may cause the robot to move Joints 3 and 4 to the positions described below. If the robot is in its workcell, it may contact other tooling and/or fixtures, causing extensive damage.

Responding N allows new test locations to be defined. The test locations must be defined so that Joint 3 moves a minimum of 100 mm, and Joint 4 moves a minimum of 180 degrees. The robot will make a quick move, causing the sensor to activate the E-STOP. The robot may overshoot slightly. To ensure the robot does not crash, it should be able to move slightly beyond the defined locations in both directions. After the new test locations are defined, Joint 3 is tested first. The following is displayed:

```
Testing Joint 3

Press the COMP/PWR button.
Hold the SPEED BAR then press and release the STEP button.
While continuing to hold the SPEED BAR, press and release
the STEP button.
The B+ amp voltage restrict has tripped as expected.
```

Joint 4 is tested in the same manner as Joint 3.

```
B+ Amp Voltage Restrict test passes.

Press ENTER to continue.
```

Press ENTER to continue with the next test or return to the main menu.

## VFP Switch and Button Test

The VFP HIGH POWER button and lamp are tested to ensure that they are operational. The following message is displayed:

```
VFP test:

LAMP TEST button test:
Press the LAMP TEST button. Do all lights come on (Y/N)?
```

If the answer is N, the test fails and the main menu is displayed. If the answer is Y, the MANUAL/AUTO and LOCAL/NETWORK keyswitches are tested by changing their position. The following is displayed:

```
Keyswitch test:
Switch the MANUAL/AUTO keyswitch to MANUAL and
LOCAL/NETWORK keyswitch to NETWORK.

Switch the MANUAL/AUTO keyswitch to AUTO and LOCAL/NETWORK
keyswitch to NETWORK.

Switch the MANUAL/AUTO keyswitch to MANUAL and
LOCAL/NETWORK keyswitch to LOCAL.

Switch the MANUAL/AUTO keyswitch to AUTO and LOCAL/NETWORK
keyswitch to LOCAL.
```

As the keyswitch positions are changed SAFE_UTL verifies their state. If the test fails, the main menu is displayed. If the test passes, the PROGRAM START button is tested and the following is displayed:

```
PROGRAM START button test:
Press and hold the PROGRAM START button.
Release the PROGRAM START button.
```

As the PROGRAM START button is pressed SAFE_UTL verifies its state. If the test fails, the main menu is displayed. If the test passes, the HIGH POWER state test is performed and the following is displayed:

```
HIGH POWER state test:
Press and hold the HIGH POWER button.
Release the HIGH POWER button.
```

As the HIGH POWER button is pressed SAFE_UTL verifies its state. If the test fails the main menu is displayed. If the test passes, the HIGH POWER enable test is performed and the following is displayed:

```
HIGH POWER Enable test:
Press and release the HIGH POWER button while the button is
flashing.
Press ENTER to begin the test.
```

After pressing ENTER the HIGH POWER button must be pressed. If the test fails, the main menu is displayed. If the test passes, the EMERGENCY STOP Button test is performed and the following is displayed:

```
EMERGENCY STOP Button test:
Press the EMERGENCY STOP.
Release the EMERGENCY STOP.
```

Press the EMERGENCY STOP button on the VFP. After releasing the EMERGENGY STOP button the test is complete. If the test fails, the main menu is displayed. If the test passes, the HIGH POWER Timeout test is performed and the following is displayed:

```
HIGH POWER Timeout test:
DO NOT press the HIGH POWER button at all.
```

After several seconds the enable power request faults and the test is complete. If the test fails, the main menu is displayed. If the test passes, the following is displayed:

```
VFP test passes.

Press ENTER to continue.
```

Press ENTER to continue with the next test or return to the main menu.

## MCP E-STOP Functions

The Hold-To-Run switch on the MCP is tested to ensure that it is operational. The following message is displayed:

```
MCP E-STOP Test:

MCP test 1:
Release the Hold-To-Run switch.
Is the red E-STOP LED on the SIO Module on (Y/N)?
```

When the Hold-To-Run switch opens, the ESTOP LED on the SIO module should turn on. If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
Attempting to enable HIGH POWER with the Hold-To-Run switch
released.
*Cat 3 external E-Stop* Code 0
```

The External E-Stop error is expected. If HIGH POWER can be switched on, the test fails and an error message is displayed. If HIGH POWER cannot be switched on the test passes.

```
MCP test 2:
Press and hold the Hold-To-Run switch.
Is the red E-STOP LED on the SIO Module off (Y/N)?
```

When the Hold-To-Run switch closes, the ESTOP LED on the SIO module should turn off. If the response is N, the test fails and an error message is displayed. If the response is Y, the system attempts to enable High Power. If High Power cannot be switched on, the test fails and an error message is displayed. If High Power is switched on the HIGH POWER button is tested.

```
Press and release the HIGH POWER button while the button is
flashing.
Press ENTER to begin the test.
Release the Hold-To-Run switch and press ENTER to continue.
```

When ENTER is pressed the system will attempt to turn on High Power. If High Power cannot be switched on, the test fails and an error message is displayed. If High Power is switched on, the MCP Hold-To-Run test passes. The next test menu is displayed.

```
Keep the Hold-To-Run switch pressed.

MCP test 3:
Press the MCP E-STOP button.
Is the red E-STOP LED on the SIO Module on (Y/N)?
Attempting to enable HIGH POWER with the E-STOP button
pressed.
*Cat 3 external E-Stop* Code 0
```

Pressing the panic button should cause an E-STOP condition.

```
MCP test 4:
Release the MCP E-STOP button.
Is the red E-STOP LED on the SIO Module off (Y/N)?
Attempting to enable HIGH POWER with the E-STOP button
released.
```

After releasing the E-STOP, the system will attempt to enable High Power. If successful, the following is displayed:

```
Press and release the HIGH POWER button while the button is
flashing.
Press ENTER to begin the test.
Press the MCP E-STOP button and press ENTER to continue.
```

When the panic button is released, the test is complete.

```
Release the MCP E-STOP button.

MCP E-STOP test passes.

Press ENTER to continue.
```

If all MCP tests pass, the next test is performed or the main menu is displayed.

## Brake Holding Force Test

The holding force of the brakes is tested to ensure that the robot cannot move when the brakes are engaged. The following message is displayed:

```
Brake Holding Force test:

The default test point is with the arm straight out and the
quill at midrange.
Do you want to define a non-default test point (Y/N)?
```

If the response is Y, the system prompts the user to move the robot to the desired location. If the response is N, the system uses the default location. The following will be displayed:

```
Press ENTER to enable power and move the robot to the test
location.
```

High Power is switched on and Joint 1 attempts to move with the brakes released. The system should not fault. Joint 1 is then tested with the brakes engaged, which induces a failure. The following is displayed:

```
Testing Joint 1

Testing with brakes released.
Press the HIGH POWER button when it blinks.
Testing with brakes engaged.
Press the HIGH POWER button when it blinks.
*Motor stalled* Mtr 1
Testing with brakes released.
Press the HIGH POWER button when it blinks.
```

After the system faults as described above Joint 1 is tested again with the brakes released. The HIGH POWER button must be pressed to switch on High Power. After testing of Joint 1 is complete, Joint 2 and 3 are also tested. On AdeptThree-MV robots Joint 4 is tested.

If the Brake Holding Force test passes and the main menu is displayed. Exit SAFE_UTL by selecting option 0 from the main menu. The following message is displayed.

```
The current robot has passed all CE Category 3 tests.

The robot will be marked as ‘commissioned’ in controller
NVRAM.
Press ENTER to continue.
```

This allows the High Power to be enabled with the MANUAL/AUTO key switch in the Manual position.

## C.4 Tests Performed Periodically

The Category 3 robot components must be tested every six months. These tests are performed using the SAFE_UTL.V2 utility as described earlier.

There are two tests in addition to the tests performed at the time of commissioning, the dual brake solenoid valve test and the dual dump valve test (AdeptThree-MV only).

When SAFE_UTL.V2 is started after the system is successfully commissioned, the utility program displays the following menu and prompts the user to select an option.

```
*** Adept CE Category 3 Test Program (Version 11.3B) ***
      Copyright (c) 1996 by Adept Technology, Inc.

                    Robot 1: xxx-xxxx

               0 => EXIT
               1 => All Tests
               2 => Accelerometer
               3 => B+ Amp Voltage Restrict
               4 => VFP Switches and Buttons
               5 => MCP E-STOP Functions
               6 => Brake Holding Force
               7 => Dual Brake Solenoid
               8 => Dual Dump Valve


                    Enter Selection:
```

**NOTE:** The Dual Dump Valve test is performed only on AdeptThree-MV robots.

In order for the robot to be marked as 'commissioned' option 1 must be selected. The other options can be selected individually to test a component that has failed a test. After testing the individual component, option 1 must be selected again to test all components. The system is marked 'commissioned' only after all tests pass.

**WARNING:** In order to perform tests on the dual brake valve and dual dump valves some access covers must be removed. HIGH POWER should be turned off and the PA-4 Amplifier Chassis should be switched off. These tests should be performed only by trained personnel.

### Required Tools

The following tools are required to perform the tests:

- AdeptOne-MV robots require a Philips screwdriver.
- AdeptThree-MV robots require a Philips screwdriver and a 5/36 inch hex wrench.
- Adept PackOne-MV robots require a 7/16 inch wrench.

## Testing the Dual Brake Valves

SAFE_UTL displays the following message:

```
Dual solenoid tests:
1. Turn off the PA-4 power chassis switch.
2. Disconnect the robot User signal cable from the security
panel and place the User jumper plug on the cable.
3. Remove the rear cover on the robot to gain access to the
solenoids.
4. Verify that both solenoids are plugged into the RSC.
```

Perform the following steps:

1. Turn High Power off then switch the PA-4 amplifier chassis switch off.
2. Disconnect the User signal cable from the Security Panel.
3. Plug the User Brake Release jumper into the User connector.
4. Remove the rear cover to gain access to the solenoid valve connections.
   - See Figure C-2 for AdeptOne-MV and AdeptThree-MV robots.
   - Robots with the HyperDrive option require that the air filter be removed using the lift tabs. The fan assembly must then be removed using a Philips screwdriver, see Figure C-3. Unplug the fan from the connector labeled J7.
   - See Figure C-5 for the Adept PackOne-MV robot. The nine bolts holding the cover in place must be removed using a 7/16 inch wrench.

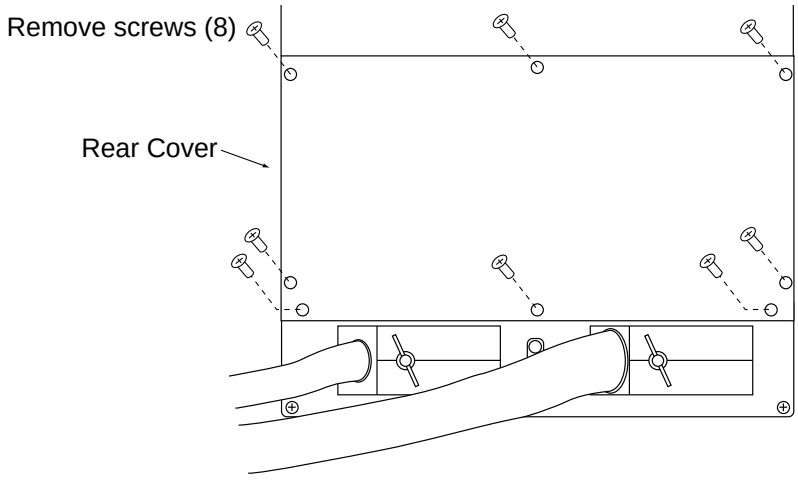


**Figure C-2. Removing the Rear Cover**

5. After the cover is removed perform the tests as described on the screen.

```
Dual Solenoid test 1:
Unplug the first solenoid from J11 on the RSC and press the
brake release button.
Do the brakes remain engaged (Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
Dual Solenoid test 2:
Plug the first solenoid into J11.
Unplug the second solenoid from J13 and press the brake
release button.
Do the brakes remain engaged (Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
Dual Solenoid test 3:
Plug the second solenoid into J13.
Press the brake release button on the RSC.
Do the brakes release (Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
While still pressing the brake release button, unplug the
first solenoid from J11.
Do the brakes engage (Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
Dual Solenoid test 4:
Plug the first solenoid into J11.
Press the brake release button on the RSC.
Do the brakes release (Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
While still pressing the brake release button, unplug the
second solenoid from J13.
Do the brakes engage (Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
Dual Solenoid test 5:
Plug the second solenoid into J13.
Press the brake release button on the RSC.
Do the brakes release(Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
Release the brake release button on the RSC.
Do the brakes engage (Y/N)?
```

6. Put the cover and/or fan assembly back in place in the reverse order that was described in step 2. On PackOne-MV robots the rear cover must be resealed. See Chapter 5 for information on resealing covers. The following message is displayed:

```
Dual brake solenoid test passes.
Replace the rear cover and turn on the PA-4 power chassis
switch.
Remove the User jumper plug and connect the USER cable to
the security panel.
Press ENTER to continue.
```

7. Turn the amplifier chassis power switch on and press ENTER.

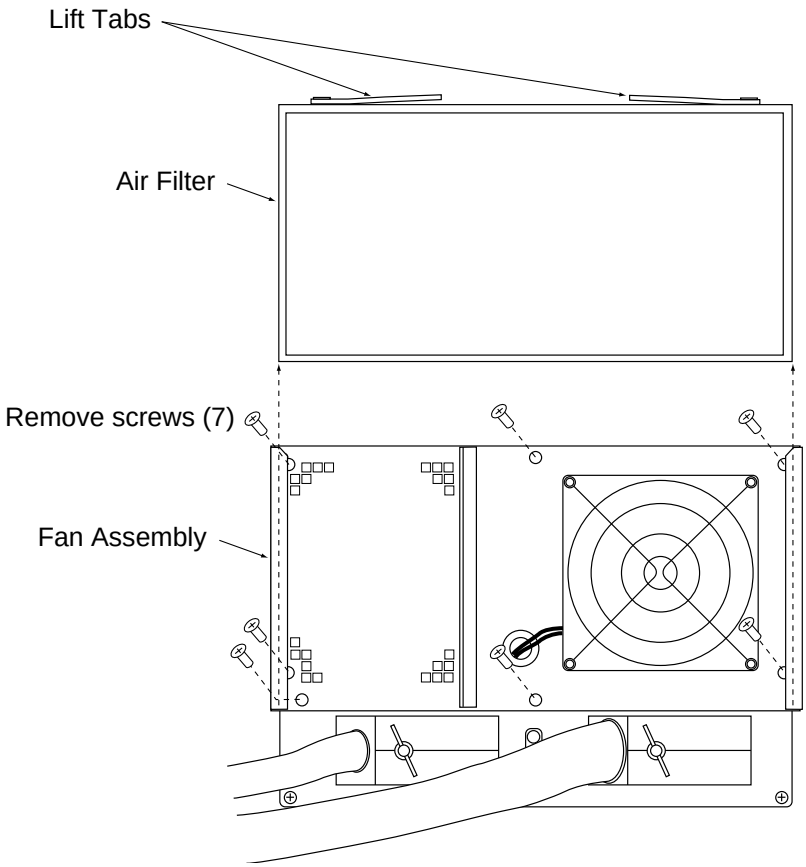


**Figure C-3. Removing the HyperDrive Fan Assembly**

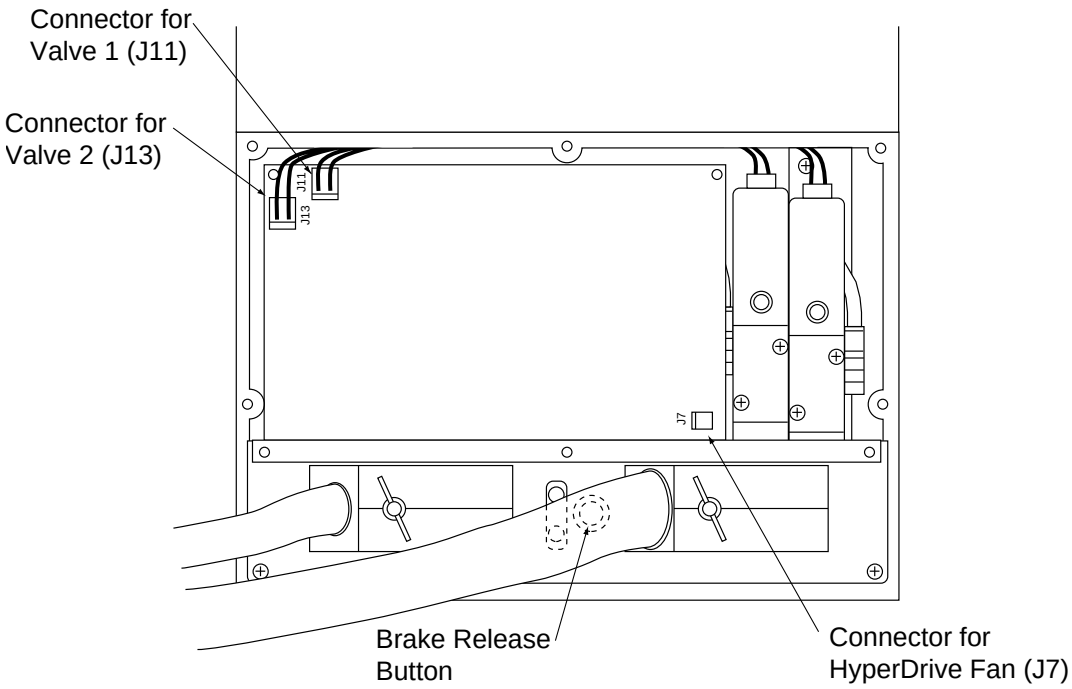


**Figure C-4. AdeptOne-MV and AdeptThree-MV Base**

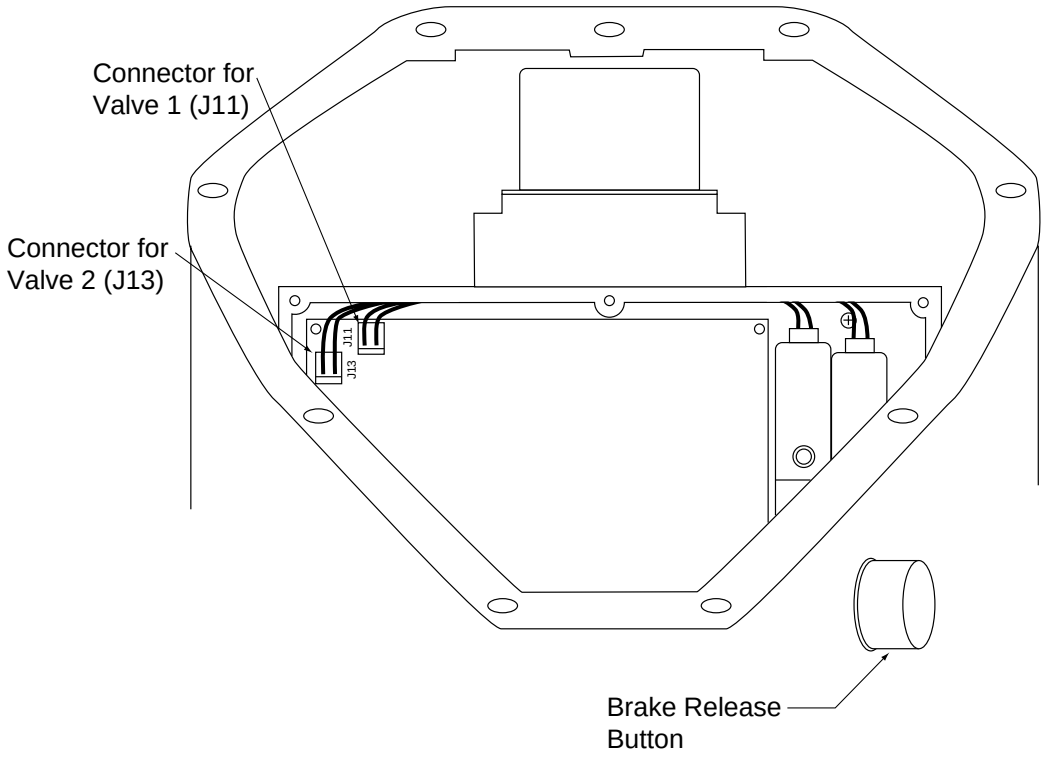


**Figure C-5. PackOne-MV Base**

## Testing the Dual Dump Valves

If the tests are being performed on an AdeptThree-MV robot, SAFE_UTL displays the following message:

```
AdeptThree Dual Dump Valve tests:
1. Turn off the PA-4 power chassis switch.
2. Disconnect the robot User signal cable from the security
panel and place the User jumper plug on the cable.
3. Raise the Joint 1 cover on the robot base to gain access
to the dump valves.
```

Perform the following steps:

1. Turn High Power off.
2. Using a 5/32" hex wrench, remove the eight screws that hold the Joint 1 cover in place.
3. Raise the Joint 1 cover and secure it to allow access to the dump valves, see Figure C-6.
4. After the cover is raised perform the tests as described on the screen.

```
Press the brake release button on the RSC.
Do the brakes release (Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
Release the brake release button.
Do both dump valves exhaust (Y/N)?
```

If the response is N, the test fails and an error message is displayed. If the response is Y, the following message is displayed:

```
AdeptThree Dump Valve test passes.

Put the Joint 1 cover back in place and turn on the PA-4
power chassis power switch.
Remove the User jumper plug and connect the USER cable to
the security panel.

Press ENTER to continue?
```

5. Lower the Joint 1 cover and secure the eight screws, then turn on the PA-4 amplifier chassis power switch.

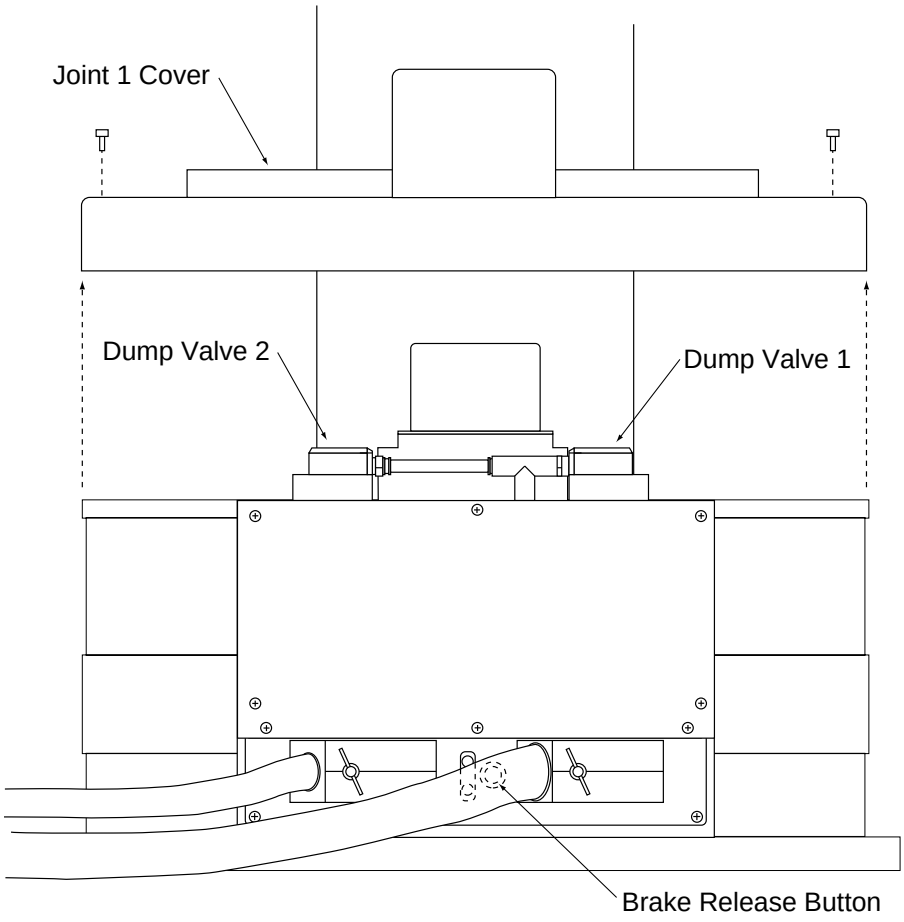


**Figure C-6. Testing the AdeptThree-MV Dump Valves**

# EMC Test Information D

## D.1 Introduction

The AdeptOne-MV, AdeptThree-MV, and Adept PackOne-MV robot systems meet all applicable requirements as mandated by the EMC Directive. Table D-1 summarizes the test results of some of the most critical tests.

**Table D-1. EMC Test Results**

| Test Performed | Status |
|---|---|
| Fast Transient Burst (FTB)<br>IEC61000-4-4 to level 3<br>(2 kV power, 1 kV I/O) | Passed without qualification |
| Electrostatic Discharge (ESD)<br>IEC61000-4-2 to level 4<br>(8 kV contact discharge) | Passed without qualification |
| Radiated Immunity<br>ENV50140 to level 3<br>(10 V/m; 80-100 MHz, 80% mod. @ 1 kHz) | 80-200 MHz: passed to 10V/m,<br>200-350 MHz: passed to 3 V/m[a],<br>350-1000 MHz: passed to 10 V/m |
| Conducted Immunity<br>ENV50141 to level 3<br>(10 V) | Passed without qualification |
| Damped Oscillatory<br>IEC255-4<br>(1 kV) | Passed without qualification |
| Gradual Shutdown and Start-up<br>IEC1131-2 | Passed without qualification |
| Surge<br>IEC1000-4-5 to level 3<br>2 kV common mode on I/Os only | Passed without qualification |
| Radiated Emissions<br>EN55011 for group 1 ISM to Class A - 2 dB | Passed without qualification |
| Conducted Emissions<br>EN55011 for group 1 ISM to Class A - 2 dB | Passed without qualification |

[a] In industrial environments with field strengths above 3 V/m in the range of 200 to 350 MHz, disturbance of normal robot operations may occur. In these cases, the robot may come to a stop but in a safe condition presenting no hazard to the operator. Therefore, it is recommended that active devices such as CB radios, cellular telephones, etc., should not be operated within 10 m of the equipment.

# Additional Robot Information E

## E.1 Compressed Air Lines In the Robot

### AdeptOne-MV and PackOne-MV Robot

#### Solenoid Valve Assembly

The solenoid valve assembly (under the Joint 2 cover) consists of two independent valves (Valve #1 and Valve #2) on a common manifold. The manifold supplies air at the user's line pressure (5.5 bar [80 psi] minimum). Each valve has two output ports, A and B. The output ports are arranged so that when Port A is pressurized, Port B is not pressurized. Conversely, when Port B is pressurized, Port A is not. In the AdeptOne-MV robot, the air lines from Port A on each valve are plugged at the factory (at the tower assembly, see Figure E-1) and the lines from Port B are routed out to the flange and are used for the User Open and Close lines; see the description of the user air lines in next section.

Mounting holes are provided to install a four-position manifold in place of the existing two-position manifold under the Joint 2 upper cover. Contact Adept Customer Service for information on this installation.

#### User Air Lines

The User Open and Close air lines are the two 5/32" air lines that run between the solenoid valve assembly and the user flange at the lower end of the quill. These lines are plugged at the flange end, and are labeled Port B Valve #1 and Port B Valve #2. They are controlled by the V+ instructions OPEN(I), CLOSE(I), and RELAX(I), or the software signals 3001 and 3002; see Table E-1.

There are two extra user air lines that run from the solenoid valve assembly to the outer link tower assembly; they are labeled Port A Valve #1 and Port A Valve #2. These extra lines are plugged at the factory, but can be used if you need two lines from each valve instead of one; see Figure E-1.

After initial installation, it is a good idea to check the positive pressure on the open and close air lines to verify that they are installed as shown in Table E-1.

**Table E-1. User Air Line Command Summary**

| State | Pneumatic Action on Port B* | V+ Command | MCP Procedure |
|---|---|---|---|
| Open | Pressure at Valve 1 on Port B, no pressure at Valve 2 on Port B** | DO OPENI (or) SIGNAL -3001, +3002 | In World, Tool, or Joint state, press T1 and plus speed bar |
| Closed | Pressure at Valve 2 on Port B, no pressure at Valve 1 on Port B** | DO CLOSEI (or) SIGNAL +3001, -3002 | In World, Tool, or Joint state, press T1 and minus speed bar |
| Relaxed | No pressure at either Valve 1 or 2 on Port B** | DO RELAXI (or) SIGNAL -3001, -3002 | In Free state, press T1 |

*Pneumatic action on Port A will be the opposite of Port B.

**No pressure indicates that the valve is connected to the return exhaust.

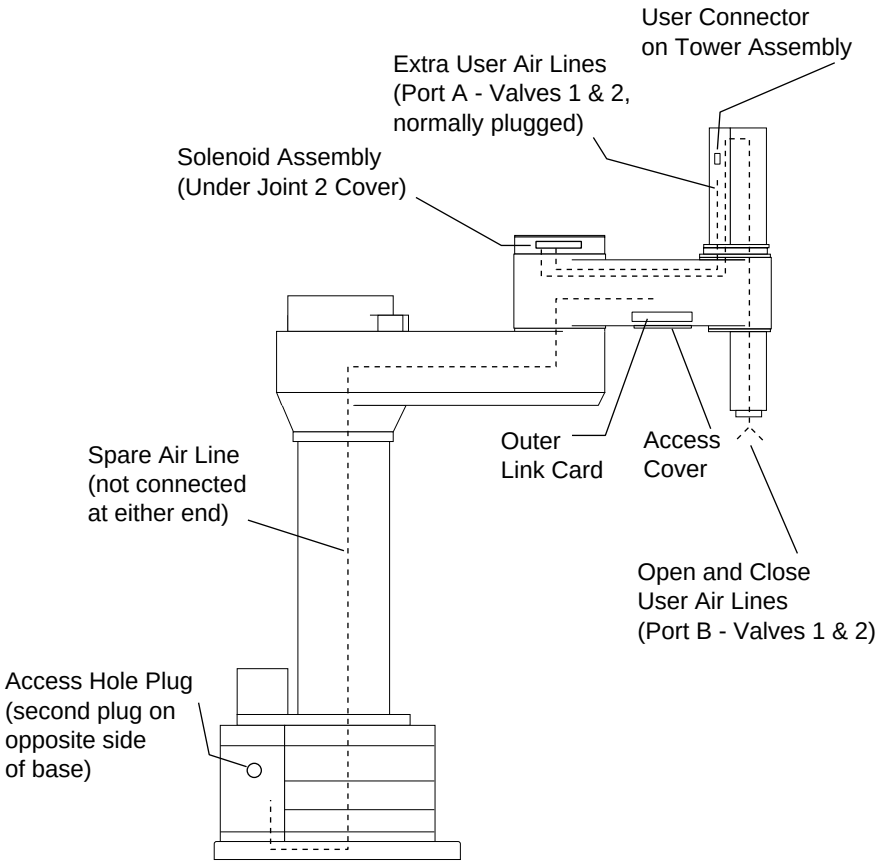


**Figure E-1. User Connections in the AdeptOne-MV Robot**

### Spare Air Line

A spare air line, 5/32", is incorporated into the robot to allow for User options. This line runs from the base of the robot up to the area near the outer link card in the outer link. The line is not supplied with connection fittings at either end. At the base, the end of the air line can be routed through either one of the access holes capped with removable plastic plugs (Figure E-1).

To access the spare air line at the base, remove eight cap-head screws that secure the base top cover, then lift and turn the cover out of the way. Be careful not to disturb exposed parts and wiring when top cover is off. At the outer link location, you can access the air line by removing the outer link access cover.

**NOTE:** This spare air line is not available on the PackOne-MV robot.

## AdeptThree-MV Robot

### Solenoid Valve Assembly

The solenoid valve assembly in the Outer Link consists of two independent valves (Valve #1 and Valve #2) on a common manifold. The manifold supplies air at the user's line pressure (5.5 bar [80 psi] minimum). Each valve has two output ports, A and B. The output ports are arranged so that when Port A is pressurized, Port B is not pressurized. Conversely, when Port B is pressurized, Port A is not. In the AdeptThree-MV robot, the air lines from Port A on each valve are plugged at the factory (at the solenoid assembly) and the lines from Port B are routed out to the flange and are used for the User Open and Close lines; see the description of the user air lines in next section.

### User Air Lines

The User Open and Close air lines are the two 5/32" air lines that run between the solenoid valve assembly and the user flange at the lower end of the quill. These lines are plugged at the flange end, and are labeled OPEN and CLOSE. They are controlled by the $V^+$ instructions OPEN(I), CLOSE(I), and RELAX(I), or the software signals 3001 and 3002; see Table E-1.

After initial installation, it is a good idea to check the positive pressure on the open and close air lines to verify that they are installed as shown in Table E-1.

### Spare Air Line

Two spare air lines, 5/32" and 1/4", are incorporated into the robot to allow for User options. These lines run from the base of the robot up to the area near the outer link card in the outer link. The lines are not supplied with connection fittings at either end. At the base, the end of the air lines can be routed through either one of the access holes capped with removable plastic plugs (Figure E-1).

To gain access to the spare air line at the base, remove eight cap-head screws that secure the base top cover, then lift and turn the cover out of the way. Be careful not to disturb exposed parts and wiring when top cover is off. At the outer link location, the air line can be accessed by removing the outer link access cover.

## E.2 Installing Extra Lines in the PackOne User Flange Assembly

The PackOne user flange assembly consists of the user flange and the Quill ID tube and cap. This entire assembly can be removed from the robot to install extra lines.

The Quill ID tube cap (see Figure 6-6 on page 119) has four pass-through holes with 5/32" union bulkhead fittings that allow lines to come from inside the robot out to the user flange. Two of these bulkhead fittings pass the Open and Close air lines that are installed at the factory. The other two fittings are plugged at both ends and are provided for running extra lines, either air or electrical, to the flange. Follow the procedure below to run extra lines.

**CAUTION:** If you remove the quill cover, you must reseal the bolts when the cover is reinstalled. Refer to the procedure in section 5.9 on page 111 for complete details. Also, the user flange assembly is sealed to prevent moisture from getting inside the robot. If you install additional electrical lines through the cap, you must ensure that a water-tight seal is maintained. Sealant recommendations are listed in the following procedure.

1. Lower the quill to its lower stop. Turn off High Power to the robot, disconnect the compressed air supply, and remove any installed end effectors. Remove the Upper Quill cover to expose the two air lines and disconnect them from the unions at the quill tower bracket.
2. Remove four 8-32 socket head cap head screws from the user flange face. This allows the entire user flange assembly to be removed from the quill so you have access to the two unused pass-through holes.
3. Remove the Quill ID tube cap from the Quill ID tube assembly by removing four plastic screws; see Figure 6-6 on page 119. Remove the plugs on either side of the two unused bulkhead fittings to install additional lines. If you are adding 5/32" air tubing, then no additional sealing is needed.

   If you are adding electrical lines or other types of lines that would not be sealed by the union fittings, then you must use a sealant to make a water-tight seal through the cap. Adept recommends:

   Dow Corning 732, multipurpose, USDA approved, silicone adhesive/sealant

   The union fittings can be unscrewed and removed if the added lines are too large to pass through; make sure to use sealant to create a water-tight seal at pass-through holes.
4. Replace the tube cap and secure with four plastic screws. Install the flange assembly back into the quill, apply Loctite 242 on the four 8-32 screws, and torque to 15 in-lb (1.7 Nm). Manually raise and lower the quill to ensure there is no binding or excess air line length at the top of the quill. Replace the quill cover and reseal the bolts per the instructions in section 5.9 on page 111.

## E.3 Outer Link Mounting Holes on AdeptOne-MV Robot

On the AdeptOne-MV robot, the mounting holes on the top side of the outer link can be used to mount user equipment. See section 1.6 on page 10 for information on limitations for modifications. Figure E-2 shows the dimensions of the mounting holes.

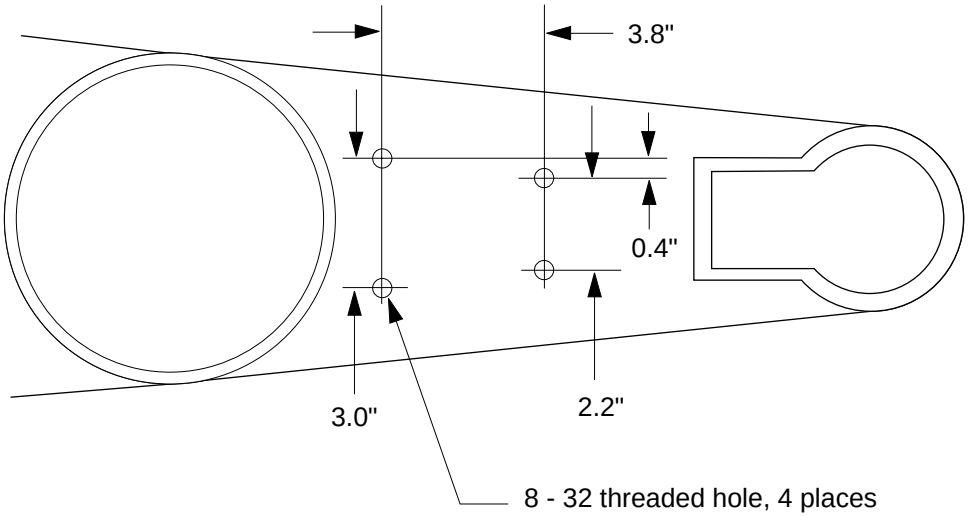


**Figure E-2. Mounting Holes on Top Side of Outer Link on AdeptOne-MV Robot**

## E.4 Limiting Joint Travel

The joint motion or travel is limited by both software and hardware limits. The programmable software limits are known as softstops; the fixed hardware limits are referred to as hardstops. (See Table E-2, Table E-2, and Table E-2.)

### Softstops

Softstops are used when the normal motion range of the robot must be limited (if other equipment is installed inside the envelope, for example). The softstops for each joint are set to their maximum value at the factory. To limit any joint's motion range, change the joint's softstop value using the SPEC utility program (formerly CONFIG_R) on the Adept Utility Disk supplied with the system. Refer to the *Instructions for Adept Utility Programs* for information regarding this utility program.

When you are using the MCP to move the robot, the robot will stop abruptly when it encounters a softstop. This abruptness does not mean a hardstop has been contacted.

### Hardstops

In most cases, the softstop will prevent joint travel from contacting a hardstop; however, contact is possible during high-speed operation. The hardstops are designed to withstand large forces without damaging the robot.

The hardstops for each joint are fixed mechanical stops. The hardstops for Joints 1, 3, and 4 are located inside the robot. The hardstops for Joint 2 are mounted externally on the inner link; they are the hard rubber cylinders that the large eyebolts pass through. The hardstops for Joint 3 are mounted at the top and bottom of the quill. The Joint 2 and 3 hardstops must not be modified in any way or damage to the robot could occur.

**Table E-2. AdeptOne-MV Robot Softstop and Hardstop Specs**

| | Default Softstop | Hardstop (approximate) |
|---|---|---|
| Joint 1 | ±150° | ±152° (Braketrack)[a]<br>±300° (Hardstop) |
| Joint 2 | ±147° | ±149.5° |
| Joint 3 Standard | 2.5 to 197.5 mm (0.1 to 7.8") | -2.5 to 202 mm (-0.1 to 7.9") |
| Joint 3 Optional | 2.5 to 297.5 mm (0.1 to 11.6″) | -2.5 to 302 mm (-0.1 to 11.9") |
| Joint 4 | ±277° | ±280° |

[a] In between the softstop and hardstop, Joint 1 has a braketrack. An internal proximity sensor will cause a $V^+$ error condition and shutdown High Power to the robot if the braketrack area is entered.

**Table E-3. AdeptThree-MV Robot Softstop and Hardstop Specs**

| | Default Softstop | Hardstop (approximate) |
|---|---|---|
| Joint 1 | ±150° | ±152° (Braketrack)[a]<br>±300° (Hardstop) |
| Joint 2 | ±150° | ±152° |
| Joint 3 | 0 to 305 mm (0 to 12") | –2.5mm to 320 mm (–0.1 to 12.6") |
| Joint 4 | ±270° | ±280° |

[a] In between the softstop and hardstop, Joint 1 has a braketrack. An internal proximity sensor will cause a $V^+$ error condition and shutdown High Power to the robot if the braketrack area is entered.

**Table E-4. Adept PackOne-MV Robot Softstop and Hardstop Specs**

| | Default Softstop | Hardstop (approximate) |
|---|---|---|
| Joint 1 | ±150° | ±152° (Braketrack)[a]<br>±300° (Hardstop) |
| Joint 2 | ±145° | ±148.6° |
| Joint 3 Standard | 0 to 196 mm (0 to 7.7") | -2.5 to 198 mm (-0.1 to 7.8") |
| Joint 3 Optional | 0 to 295 mm (0 to 11.6″) | -2.5 to 297 mm (-0.1 to 11.7") |
| Joint 4 | ±277° | ±280° |

[a] In between the softstop and hardstop, Joint 1 has a braketrack. An internal proximity sensor will cause a $V^+$ error condition and shutdown High Power to the robot if the braketrack area is entered.

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# Adept User's Manual Comment Form

We have provided this form to allow you to make comments about this manual, to point out any mistakes you may find, or to offer suggestions about information you want to see added to the manual. We review and revise user's manuals on a regular basis, and any comments or feedback you send us will be given serious consideration. Thank you for your input.

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